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HEATHKIT® MANUAL

for the

Hand-Held 512 MHz Frequency Counter

Model IM-2400

595-2382

HEATH COMPANY • BENTON HARBOR, MICHIGAN

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HEATH COMPANY
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Kit orders and delivery information	(616) 982-3411
Credit	(616) 982-3561
Replacement Parts	(616) 982-3571

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Heathkit® Manual

for the

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HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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INTRODUCTION

The Heathkit Model IM-2400 Hand-Held Frequency Counter is a compact, easy-to-use, instrument which can accurately measure frequencies to over 512 MHz.

Designed for portable use, this Frequency Counter contains five rechargeable, AA size, nickel-cadmium batteries. You can easily charge the batteries using one of the required Heathkit battery charger/eliminator accessories* available for this kit.

Excellent accuracy is assured by a modern digital design and a 10 MHz crystal oscillator. Additional features include a rugged and compact cabinet, and a pivoting stand to support the instrument at a more convenient viewing angle. This carefully designed Frequency Counter will provide long, reliable, performance for your laboratory, workbench, or portable applications.

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*Model PS-2404 for 120 VAC operation and Model PS-2405 for 240 VAC operation.

PARTS LIST

Unpack the kit and check each part against the following list. The key numbers correspond to the numbers in the Parts Pictorial (Illustration Booklet, Pages 1 thru 6). Return any part that is packed in an individual envelope back to the envelope after you identify it. Keep these parts in the envelopes until they are called for in an assembly step. Do NOT throw away any packing material until you account for all the parts.

To order a replacement part, always include the Part Number. Use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of this Manual. For prices, refer to the separate "Heath Parts Price List."

This kit uses a separate "Illustration Booklet" that contains illustrations (Pictorials, Details, etc.) in addition to those included in the Assembly Manual. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in Pictorial number sequence.

Each circuit part in this kit has its own component number (R2, C4, etc.). Use these numbers when you want to identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:

- In the Parts List,
- At the beginning of each step where a component is installed,
- In some illustrations,
- In the Schematic,
- In the sections at the rear of the Manual.

RESISTORS

NOTES:

1. Resistors may be packed in more than one envelope. Open all of the resistor envelopes before you check the resistors against the following list.

2. The following resistors have a tolerance of 5% unless otherwise noted. 5% tolerance is indicated by a gold fourth band. 10% tolerance is indicated by a silver fourth band. This fourth band (gold or silver) is not called out below or in the steps.

1/4-Watt

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	6-100-12	4 ✓	10 Ω (brn-blk-blk)	R4, R17, R32, R39
A1	6-330-12	1 ✓	33 Ω (org-org-blk)	R26
A1	6-680-12	1 ✓	68 Ω (blu-gry-blk)	R35
A1	6-750-12	2 ✓	75 Ω (viol-grn-blk)	R33, R34
A1	6-101-12	2 ✓	100 Ω (brn-blk-brn)	R27, R31
A1	6-151-12	2 ✓	150 Ω (brn-grn-brn)	R21, R42
A1	6-221-12	10 ✓	220 Ω (red-red-brn)	R5, R8, R9, R11, R12, R15, R16, R44, R45, R46
A1	6-241-12	2 ✓	240 Ω (red-yel-brn)	R19, R38
A1	6-561-12	4 ✓	560 Ω (grn-blu-brn)	R14, R22, R23, R24
A1	6-911-12	2 ✓	910 Ω (wht-brn-brn)	R18, R37
A1	6-102-12	4 ✓	1000 Ω (brn-blk-red)	R3, R6, R7, R13
A1	6-182-12	2 ✓	1800 Ω (brn-gry-red)	R28, R29
A1	6-103-12	5 ✓	10 kΩ (brn-blk-org)	R41, R43, R47, R48, R49
A1	6-183-12	1 ✓	18 kΩ (brn-gry-org)	R36
A1	6-104-12	1 ✓	100 kΩ (brn-blk-yel)	R2
A1	6-105-12	1 ✓	1 MΩ (brn-blk-grn)	R1
A1	1-88-12	1 ✓	10 MΩ, 10% (brn-blk-blu)	R51

OK

OK

1/2-Watt

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A2	6-470	1 ✓	47 Ω (yel-viol-blk)	R25

CAPACITORS

Mica

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
B1	20-77	1✓	24 pF	C32
B1	20-190	1✓	51 pF	C2
B1	20-102	1✓	100 pF	C7
B1	20-139	1✓	330 pF	C4

OK

Ceramic

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
B2	21-54	1✓	75 pF, N750	C34
B3	21-711	3✓	470 pF (471)	C13, C16 C21
B3	21-717	13✓	.01 μF (103)	C3, C9 C11, C14 C17, C18 C19, C22 C23, C24 C25, C28 C36
B3	21-192	1✓	.1 μF (104)	C31

OK

OK

Tantalum

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
B4	25-838	1	3.3 μF	C35
B4	25-276	1✓	4.7 μF	C6
B5	25-211	1✓	33 μF	C5
B4	25-281	2✓	39 μF	C15, C29

Electrolytic

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
B6	25-912	2✓	3.3 μF	C26, C27
B6	25-918	1✓	100 μF	C12
B6	25-919	1✓	150 μF	C8

OK

Other Capacitors

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
B7	29-64	1✓	.15 μF polycarbonate	C1
B8	31-93	1✓	4-40 pF trimmer	C33

OK

DIODES

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
C1	56-56	6 ✓	1N4149	D3, D4 D9, D11 D12, D13
C1	56-86	2 ✓	FD777	D1, D2
C1	56-87	4 ✓	FH1100	D5, D6 D7, D8
C1	56-616	1 ✓	1N5232 zener	D14

OK

TRANSISTORS — INTEGRATED CIRCUITS (IC's)

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits, use **only** those numbers and letters in **BOLD** print. Disregard any other numbers or letters.)
3. Part number and type number.
4. Part number with a type number other than the one shown.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
C2	417-292	2 ✓	2N5771 transistor	Q3, Q5
C2	417-293	3 ✓	2N5770 transistor	Q2, Q4 Q6
C3	417-818	1 ✓	MJE181 transistor	Q11
C4	417-828	1 ✓	Selected E304 transistor	Q1

OK

Transistors — Integrated Circuits (IC's) (cont'd.)

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
C2	417-881	3 ✓	MPSA13 transistor	Q7, Q8 Q9
C5	442-698	1 ✓	SL952 IC	U2
C5	443-628	1 ✓	SN**74196** IC	U5
C6	443-723	1 ✓	MC**10216** IC	U1
C6	443-935	1 ✓	SN**74S153** IC	U4
C6	443-937	1 ✓	SP8685B IC	U3

OK

NOTE: The following IC is packed in a special foam material to protect it from possible damage due to static electricity. Do not remove this IC from its protective foam material until you are instructed to do so.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
C7	443-938	1 ✓	ICM**7216D** IC	U6

OTHER ELECTRONIC PARTS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
D1	60-636	2 ✓	DPDT switch	SW2, SW3
D2	60-637	1 ✓	SPDT switch	SW1
D3	404-426	1 ✓	10 MHz crystal	Y1
D4	411-825	7 ✓	LED display	V1-V7
	418-32	5 ✓	Battery	
D5	475-15	1 ✓	Ferrite bead	

OK

JACKS — SOCKETS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
E1	432-59	2 ✓	BNC jack	J1, J3
E2	434-298	1 ✓	14-pin IC socket	
E3	434-299	3 ✓	16-pin IC socket	
E4	434-312	1 ✓	28-pin IC socket	
E5	434-340	14 ✓	5-pin socket strip	
E6	436-49	1 ✓	Power jack	J2

OK

HARDWARE

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
F1	250-366	4	4-40 × 3/16″ screw	
F2	250-52	4	4-40 × 1/4″ screw	
F3	252-15	4	Small 4-40 nut	
F4	252-2	4	Large 4-40 nut	
F5	254-9	2	#4 lockwasher	
F6	255-770	2	4-40 × 3/8″ spacer	
F7	250-1300	3	#6 × 5/8″ self-tapping screw	
F8	259-27	2	3/8″ solder lug	

OK

CASE PARTS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
	305-86	1 ✓	Case parts consisting of:	
G1	*92-713*	*1* ✓	*Case top*	
G2	*92-714*	*1* ✓	*Case bottom*	
G3	*94-617*	*1* ✓	*End panel*	

OK

CABLE — WIRES

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
H1	134-1094	1 ✓	8-wire ribbon cable	
	344-90	24″ ✓	Black wire	
	344-92	12″ ✓	Red wire	

OK

METAL PARTS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
J1	204-2470	1 ✓	Circuit board bracket	
J2	205-1819	1 ✓	Input panel	
J3	206-1345	1 ✓	Circuit board shield	

OK

MISCELLANEOUS

Ok

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
K1	73-64	2 ✓	Foam gasket	
K2	73-141	1 ✓	Foam strip	
	74-6	1 ✓	Roll of tape	
	75-90	1 ✓	Insulating paper	
K3	75-782	1 ✓	Power jack insulator	
	~~85-2404-2~~ 85-2404-1	1 ✓	Main circuit board	
	85-2405-1	1 ✓	Display circuit board	
K4	205-778	1 ✓	1″ blade	
K5	211-87 ✓	1 ✓	Bail	
K6	490-5	1 ✓	Nut starter	
K7	490-111	1 ✓	IC lifter	
	490-185	1 ✓	Package of desoldering braid	
		✓	Solder	

PRINTED MATERIAL

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
L1	390-1745	1	Function label	
L2	390-1760	1	Caution label	
L3		1	Blue and white label	
L4	391-639	1	Name plate	
	597-260	1	Parts Order Form	
	597-308	1	Kit Builder's Guide	
		1	Assembly Manual (See Page 1 for part number.)	

ASSEMBLY NOTES

IMPORTANT: Before you start to assemble your Frequency Counter, it is very important that you read the following information on step-by-step assembly procedures, wiring, and soldering. Also read the information in the "Kit Builder's Guide."

ASSEMBLY

1. Follow the instructions carefully and read the entire step before you perform the operation.

2. The illustrations in this Manual are called Pictorials and Details. Pictorials show the overall operation for a group of assembly steps; Details generally illustrate a single step. When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.

SOLDERING

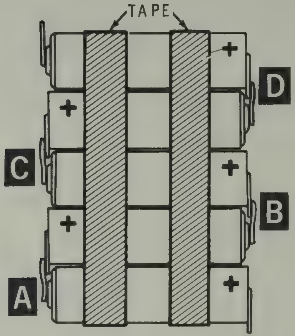
1. Due to the small area around some circuit board holes and the small areas between some foils, use care to prevent solder bridges between adjacent foil areas. Use only a **minimum amount of solder** and do not heat components excessively with the soldering iron. **Use no larger than a 40-watt soldering iron with a 1/8" to 3/16" pyramid or chisel tip.** Allow it to reach operating temperature; then apply it only long enough to make a good solder connection. If you think a solder bridge may exist, compare the foil on the circuit board with the "Circuit Board X-Ray Views" in the rear of this Manual.

2. Remember to keep the soldering iron tip clean. Wipe it often on a damp sponge or cloth; then apply solder to the tip to give the entire tip a wet look.

3. The circuit boards in this kit have foil on both sides. Note that the "component" (or lettered) side of each circuit board has the outline of each component screened on it. All components will be mounted on this side of the circuit board and soldered to the **other** side . Do **NOT** solder on the component side of the circuit board unless you are instructed to do so.

4. The assembly of the main circuit board is divided into two sections. Refer to Pictorial 2-1 (Illustration Booklet, Page 7). Except for the five integrated circuits, all components will be installed in one section before you proceed to the other section.

5. Due to the nature of the foil pattern on each circuit board, solder may be drawn through a circuit board hole from the foil side to the lettered side. **This is normal**, as many of the holes are "plated through" to connect the foil on both sides of the circuit board together. However, do not allow solder to flow into adjacent unused holes when you solder components to the foil.



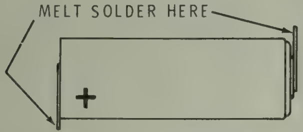
PICTORIAL 1-1

STEP-BY-STEP ASSEMBLY

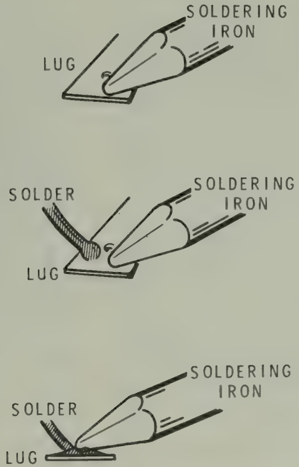
ok

BATTERIES

Refer to Pictorial 1-1 for the following steps.



Detail 1-1A



Detail 1-1B

- ☑ Refer to Detail 1-1A and make sure both tabs of a battery are straight as shown. Then melt a small amount of solder onto both tabs as shown in Detail 1-1B.
- ☑ In a similar manner, melt solder onto the tabs of the remaining four batteries.
- ☑ Position the five batteries so their plus (+) ends are as shown in the Pictorial. Be sure the batteries are as close together as possible. Then solder the tabs together at A, B, C, and D.
- ☑ Wrap the tape at least three times around the batteries at the two locations shown in the Pictorial.
- ☑ Set the batteries aside until they are called for in a step.

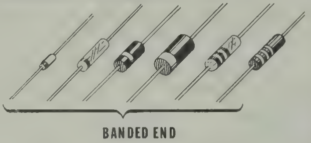
MAIN CIRCUIT BOARD

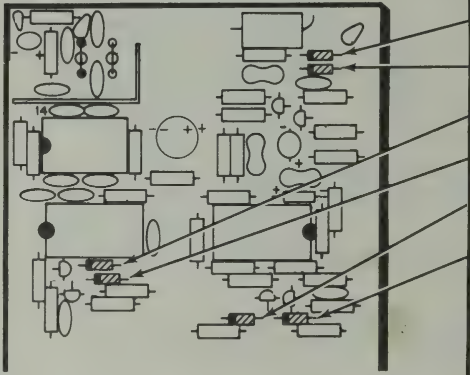
START

( ) Position the main circuit board as shown in Pictorial 2-2 with the lettered side up.

NOTE: On the following Pictorials, you will install components in section A of the circuit board. See Pictorial 2-1 (Illustration Booklet, Page 7).

IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.





PICTORIAL 2-2

CONTINUE

NOTE: When you install diodes, as in the following steps, be sure you position the banded end of each diode as it is shown on the circuit board.

(✓) D1: FD777 diode (#56-86).

(✓) D2: FD777 diode (#56-86).

(✓) D9: 1N4149 diode (#56-56).

(✓) D11: 1N4149 diode (#56-56).

(✓) D4: 1N4149 diode (#56-56).

(✓) D3: 1N4149 diode (#56-56).

IMPORTANT: When you are instructed to "cut off the excess lead lengths," as in the following step, make sure you cut each lead off as close to the foil as possible.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

NOTE
BOARD SAYS 47 Ω
ITS NOT—
IT SUD SAY
68 Ω

START

(✓) R27: 100 Ω (brn-blk-brn).

(✓) R31: 100 Ω (brn-blk-brn).

(✓) R35: 68 Ω (blu-gry-blk).

(✓) R32: 10 Ω (brn-blk-blk).

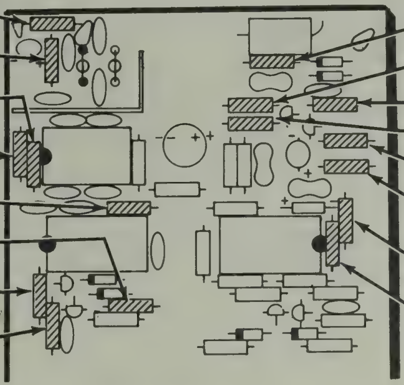
(✓) R36: 18 kΩ (brn-gry-org).

(✓) R37: 910 Ω (wht-brn-brn).

(✓) R39: 10 Ω (brn-blk-blk).

(✓) R38: 240 Ω (red-yel-brn).

(✓) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 2-3

CONTINUE

(✓) R1: 1 MΩ (brn-blk-grn).

(✓) R2: 100 kΩ (brn-blk-yel).

(✓) R4: 10 Ω (brn-blk-blk).

(✓) R3: 1000 Ω (brn-blk-red).

(✓) R5: 220 Ω (red-red-brn).

(✓) R8: 220 Ω (red-red-brn).

(✓) R9: 220 Ω (red-red-brn).

(✓) R15: 220 Ω (red-red-brn).

(✓) Solder the leads to the foil and cut off the excess lead lengths.

START

(✓) R12: 220 Ω (red-red-brn).

(✓) R34: 75 Ω (viol-grn-blk).

(✓) R33: 75 Ω (viol-grn-blk).

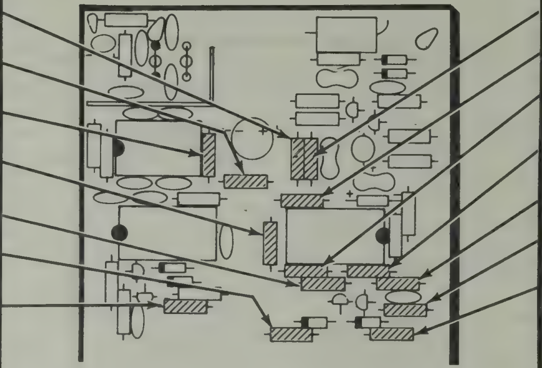
(✓) R7: 1000 Ω (brn-blk-red).

(✓) R16: 220 Ω (red-red-brn).

(✓) R18: 910 Ω (wht-brn-brn).

(✓) R42: 150 Ω (brn-grn-brn).

(✓) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 2-4

CONTINUE

(✓) R11: 220 Ω (red-red-brn).

(✓) R6: 1000 Ω (brn-blk-red).

(✓) R13: 1000 Ω (brn-blk-red).

(✓) R14: 560 Ω (grn-blu-brn).

(✓) R17: 10 Ω (brn-blk-blk).

(✓) R19: 240 Ω (red-yel-brn).

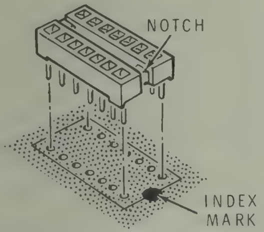
(✓) R21: 150 Ω (brn-grn-brn).

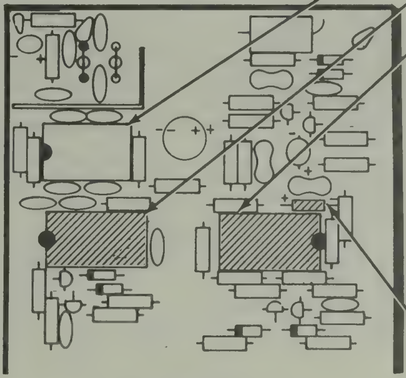
NOTE; In the following step, save three cutoff resistor leads for use later.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

START

You will install IC sockets in the following steps. Be sure the socket pins are straight. Insert the pins in their respective holes, turn the circuit board over, and solder the pins to the foil. Be sure the socket is down against the circuit board and all the pins protrude through the circuit board.





PICTORIAL 2-5

CONTINUE

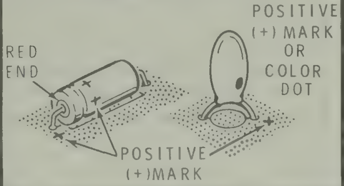
Do NOT install an IC socket at this location.

(✓) 16-pin IC socket.

(✓) 16-pin IC socket.

(✓) Cut off any excess pin lengths.

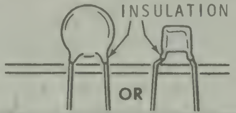
NOTE: When you install tantalum capacitors, be sure to match the positive (+) mark or color dot on the capacitor with the positive (+) mark on the circuit board as shown.



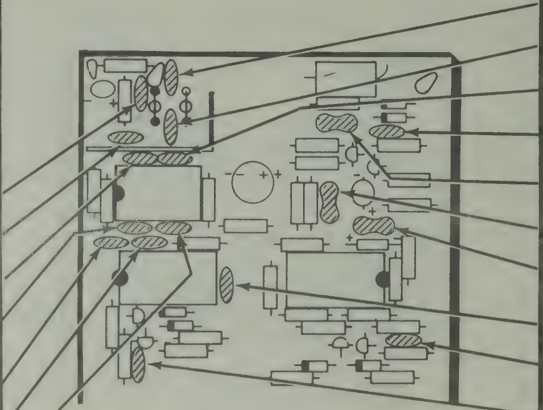
( ) C5: 33 μF tantalum. Solder the leads to the foil and cut off the excess lead lengths.

START

NOTE: When you install ceramic capacitors, do not push the insulated portion of the leads into the circuit board holes. This could make it difficult to solder the leads to the foil.



- (✓) C14: .01 μF (103) ceramic.
- (✓) C19: .01 μF (103) ceramic.
- (✓) C17: .01 μF (103) ceramic.
- (✓) C21: 470 pF (471) ceramic.
- (✓) C25: .01 μF (103) ceramic.
- (✓) C23: .01 μF (103) ceramic.
- (✓) C22: .01 μF (103) ceramic.
- (✓) Solder the leads to the foil and cut off the excess lead lengths.



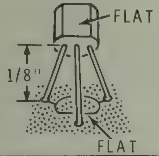
PICTORIAL 2-6

CONTINUE

- (✓) C13: 470 pF (471) ceramic.
- (✓) C16: 470 pF (471) ceramic.
- (✓) C22: .01μF (103) ceramic.
- (✓) C3: .01 μF (103) ceramic.
- (✓) C2: 51 pF mica.
- (✓) C7: 100 pF mica.
- (✓) C4: 330 pF mica.
- (✓) C24: .01 μF (103) ceramic.
- (✓) C9: .01 μF (103) ceramic.
- (✓) C28: .01 μF (103) ceramic.
- (✓) Solder the leads to the foil and cut off the excess lead lengths.

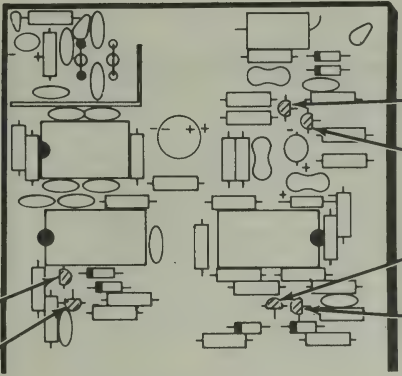
START

NOTE: Install the following transistors in the manner shown. First line up the flat on the transistor with the outline of the flat on the circuit board. Insert the transistor leads into the corresponding holes. Position the transistor 1/8" above the circuit board before you solder each lead to the foil. Cut off the excess lead lengths.



(✓) Q5: 2N5771 transistor (#417-292).

(✓) Q6: 2N5770 transistor (#417-293).



PICTORIAL 2-7

CONTINUE

(✓) Q1: Selected E304 transistor (#417-828).

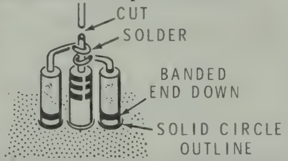
(✓) Q2: 2N5770 transistor (#417-293).

(✓) Q3: 2N5771 transistor (#417-292).

(✓) Q4: 2N5770 transistor (#417-293).

START

NOTE: Mount the following resistor and two diodes vertically with the top lead of each diode connected to the top lead of the resistor as shown. Be sure the lead at the **banded end** of each diode is **down** over the solid circle outline on the circuit board. Solder each component to the foil as you install it. Also solder the top connection.



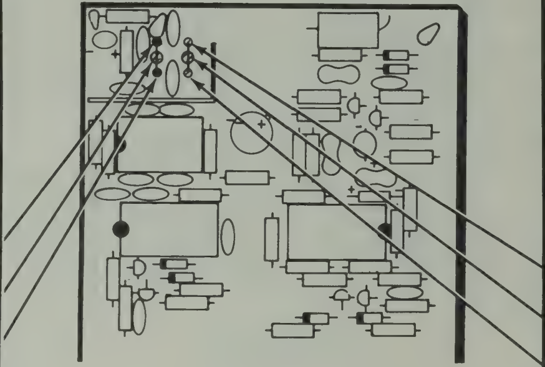
(✓) D5: FH1100 diode (#56-87).

(✓) R28: 1800 Ω (brn-gry-red).

(✓) D6: FH1100 diode (#56-87).

(✓) Cut off any excess lead lengths.

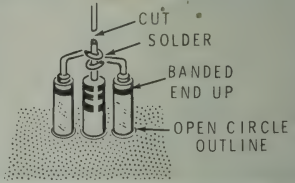
IMPORTANT: In the following step, make sure you install the two diodes with the banded end up.



PICTORIAL 2-8

CONTINUE

NOTE: Mount the following resistor and two diodes vertically with the top lead of each diode connected to the top lead of the resistor as shown. Be sure the lead **opposite the banded end** of each diode is **down** over the open circle outline on the circuit board. Solder each component to the foil as you install it. Also solder the top connection.



(✓) D7: FH1100 diode (#56-87).

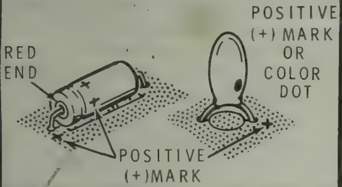
(✓) R29: 1800 Ω (brn-gry-red).

(✓) D8: FH1100 diode (#56-87).

(✓) Cut off any excess lead lengths.

START

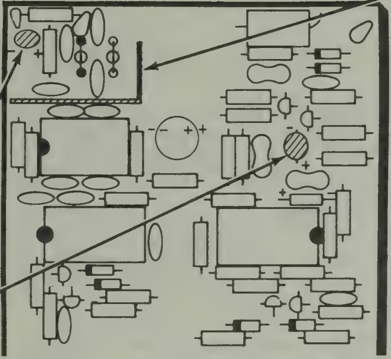
NOTE: When you install tantalum capacitors, be sure to match the positive (+) mark or color dot on the capacitor with the positive (+) mark on the circuit board as shown.



(✓) C15: 39 μF tantalum.

(✓) C6: 4.7 μF tantalum.

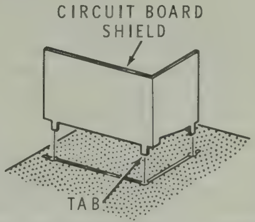
(✓) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 2-9

CONTINUE

(✓) Circuit board shield. Push the shield firmly down so it is properly seated against the circuit board. Then solder the tabs to the foil.



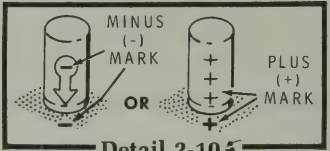
START

(✓) Locate the three cutoff resistor leads that you were instructed to set aside earlier.

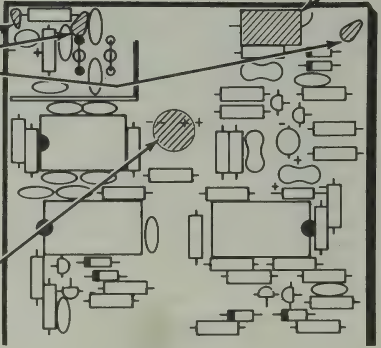
(✓) Install and solder a cutoff resistor lead in each of the three indicated circuit board holes (L, S, and T). Be sure the free end of each lead is at least 3/4″ above the **component** side of the circuit board. Then cut off any excess lead lengths from the **foil** side of the circuit board.

NOTE: When you install electrolytic capacitors, always match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board OR match the minus (−) mark on the capacitor with the minus (−) mark on the circuit board. See Detail 2-10A. Then solder the leads to the foil and cut off the excess lead lengths.

(✓) C8: 150 μF electrolytic.



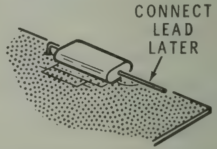
Detail 2-10A

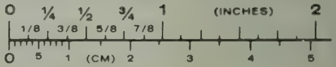


PICTORIAL 2-10

CONTINUE

(✓) C1: Cut both leads of a .15 μF polycarbonate capacitor to 1/2″. Then insert either lead into the circuit board hole for this capacitor. Position the capacitor down against the circuit board as shown. Then solder the lead to the foil and cut off the excess lead length. The other capacitor lead will be connected later.





START

NOTE: On the following Pictorials, you will install components in section B of the circuit board. See Pictorial 2-1 (Illustration Booklet, Page 7).

(✓) R41: 10 kΩ (brn-blk-org).

(✓) R23: 560 Ω (grn-blu-brn).

(✓) R22: 560 Ω (grn-blu-brn).

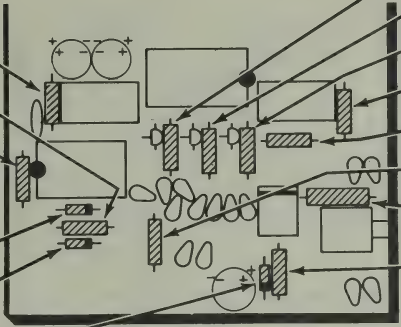
NOTE: In the following three steps, be sure you position the banded end of each diode as shown on the circuit board.

(✓) D12: 1N4149 diode (#56-56).

(✓) D13: 1N4149 diode (#56-56).

(✓) D14: 1N5232 diode (#56-616).

(✓) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 2-11

CONTINUE

(✓) R44: 220 Ω (red-red-brn).

(✓) R45: 220 Ω (red-red-brn).

(✓) R46: 220 Ω (red-red-brn).

(✓) R43: 10 kΩ (brn-blk-org).

(✓) R47: 10 kΩ (brn-blk-org).

(✓) R24: 560 Ω (grn-blu-brn).

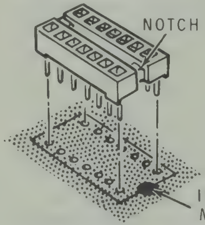
(✓) R25: 47 Ω, 1/2-watt (yel-viol-blk).

(✓) R26: 33 Ω (org-org-blk).

(✓) Solder the leads to the foil and cut off the excess lead lengths.

START

NOTE: You will install IC sockets in the following steps. Be sure the socket pins are straight. Insert the pins in their respective holes, turn the circuit board over, and solder the pins to the foil. Be sure the socket is down against the circuit board and all the pins protrude through the circuit board.



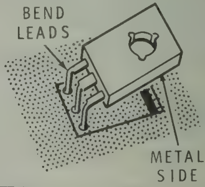
CONTINUE

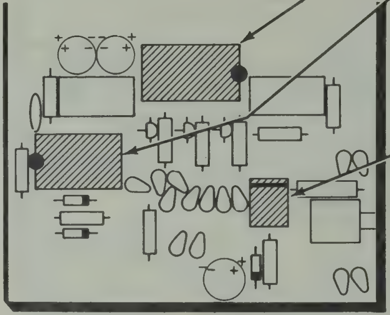
(✓) 16-pin IC socket.

(✓) 14-pin IC socket.

(✓) Cut off any excess pin lengths.

(✓) Q11: MJE181 transistor (#417-818). Use a pair of needle-nose pliers and bend the three transistor leads towards the metallic side of the transistor as shown. Then insert the leads in the proper circuit board holes. Space the transistor 1/16″ above the circuit board before you solder the leads to the foil. Finally, cut off the excess lead lengths.



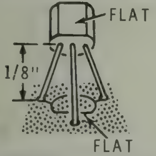


PICTORIAL 2-12

START

(✓) C11: .01 μF (103) ceramic. Solder the leads to the foil and cut off the excess lead lengths.

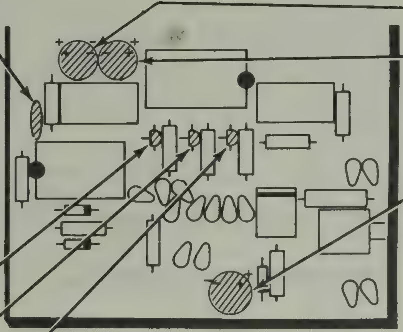
NOTE: Install the following transistors in the manner shown. First line up the flat on the transistor with the outline of the flat on the circuit board. Insert the transistor leads into the corresponding holes. Solder each lead to the foil and cut off the excess lead lengths.



(✓) Q7: MPSA13 transistor (#417-881).

(✓) Q8: MPSA13 transistor (#417-881).

(✓) Q9: MPSA13 transistor (#417-881).



PICTORIAL 2-13

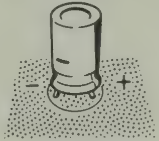
CONTINUE

NOTE: Make sure you do not install the 3.3 μF tantalum capacitor in any of the following two steps.

(✓) C26: 3.3 μF electrolytic.

(✓) C27: 3.3 μF electrolytic.

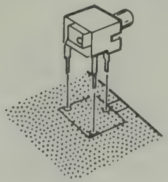
(✓) C12: 100 μF electrolytic.



(✓) Solder the leads to the foil and cut off the excess lead lengths.

START

(✓) J2: Power jack. Push the jack firmly down so it is properly seated against the circuit board. Then solder the lugs to the foil and cut off any excess lug lengths.

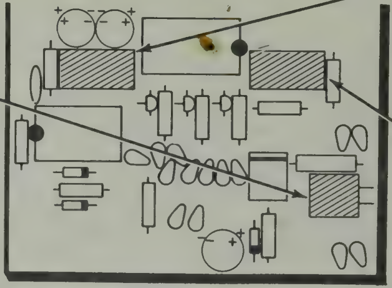


CONTINUE

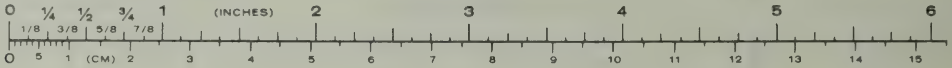
(✓) SW2: DPDT switch. Insert the switch pins into the proper circuit board holes. Push the switch down until it is properly seated. Make sure it is perpendicular to the circuit board. Then turn the board over and solder the pins to the foil. Finally, cut off the excess pin lengths.

(✓) SW3: Similarly, install the other DPDT switch.

(✓) Make sure no solder bridges exist between the pins of switches SW2 or SW3.



PICTORIAL 2-14



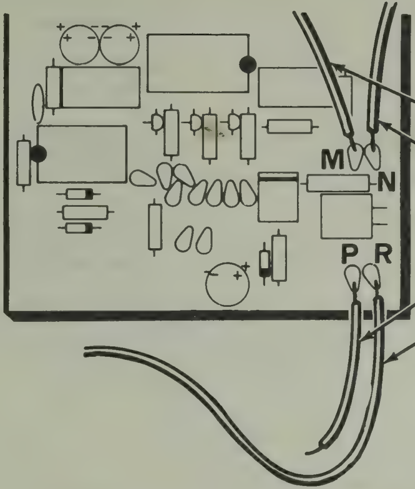
START

NOTE: When you are instructed to prepare a wire, cut it to the indicated length and remove 1/4" of insulation from each end. Then twist the small wire strands together and melt a small amount of solder on the bare wire ends to hold the strands together.

(✓) Prepare the following wires:

Two 5" black
One 1" red
One 5-1/4" black

NOTE: In the following steps, connect one end of each wire to the lettered side of the circuit board. Then solder the wires to the foil, and cut off the excess wire lengths on the other side of the circuit board.



PICTORIAL 2-15

CONTINUE

(✓) 5" black wire to hole M.

(✓) 5" black wire to hole N.

( ) 1" red wire to hole P.

( ) 5-1/4" black wire to hole R.

Circuit Board Checkout

Carefully inspect the foil side of the circuit board for the following most commonly made errors.

( ) Unsoldered connections.

( ) Poor solder connections.

( ) Solder bridges between foil patterns.

( ) Protruding leads which could touch together when the circuit board is installed later.

Refer to the illustration where the parts where installed as you make the following visual checks.

( ) Transistors for the proper **type** and **installation**.

( ) Diodes for the proper **type and installation**.

( ) Tantalum capacitors for the correct position of the positive (+) or dot marked lead.

( ) Electrolytic capacitors for the correct position of the (+) or (−) marked lead.

Set the main circuit board aside temporarily.

DISPLAY CIRCUIT BOARD

START

(✓) Position the display circuit board as shown with the lettered side up. Then complete each step on the following Pictorials.

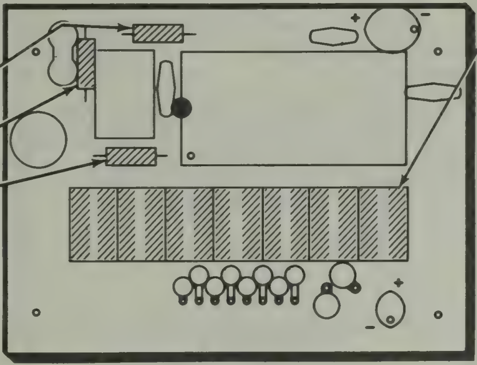
(✓) R48: 10 kΩ (brn-blk-org).

(✓) R51: 10 MΩ (brn-blk-blu).

(✓) R49: 10 kΩ (brn-blk-org).

(✓) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: In the following step, make sure each socket strip is perpendicular to the circuit board before you solder the pins to the foil. When you install two strips right next to each other, make sure their thin-walled sides face each other. See Detail 3-1A.

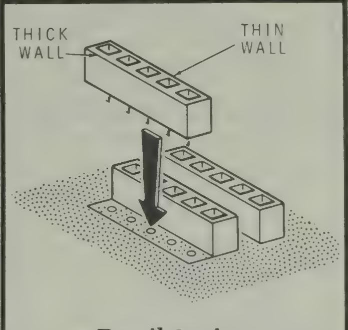


PICTORIAL 3-1

CONTINUE

(✓) Install fourteen 5-pin socket strips. Solder the pins of each part to the foil as you install it.

(✓) Cut off any excess pin lengths.



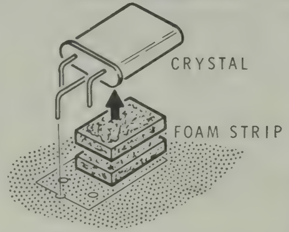
Detail 3-1A

START

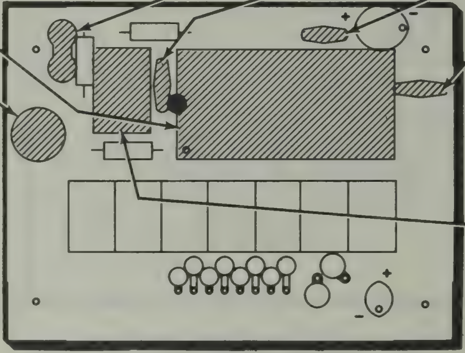
NOTE: The 28-pin IC socket can be installed in either direction. Be sure the socket pins are straight before you install it in the following step. Be sure all of the pins are through the circuit board before you solder them to the foil.

(✓) 28-pin IC socket at U6. Cut off any excess pin lengths.

(✓) C33: 4-40 pF trimmer capacitor (#31-93). Solder the lugs to the foil and cut off the excess lug lengths.



Detail 3-2A



PICTORIAL 3-2

CONTINUE

(✓) C32: 24 pF mica.

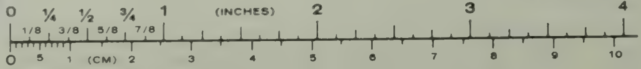
(✓) C34: 75 pF, N750 ceramic.

(✓) C36: .01 μF (103) ceramic.

(✓) C31: .1 μF (104) ceramic.

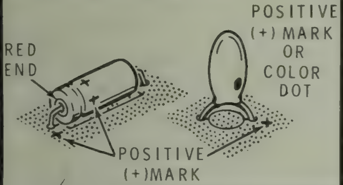
(✓) Solder the leads to the foil and cut off the excess lead lengths.

( ) Y1: Bend the leads of the 10 MHz crystal (#404-426) at a 90° angle as shown in Detail 3-2A. Remove the backing paper from one side of two 3/8" pieces of foam strip. Then press the foam strips onto the indicated side of the crystal. Insert the three crystal leads into the proper circuit board holes and push the crystal down against the circuit board. Finally, solder the leads to the foil and cut off the excess lead lengths.



START

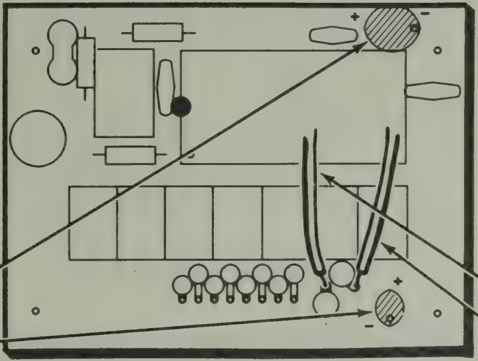
NOTE: When you install tantalum capacitors, be sure to match the positive (+) mark or color dot on the capacitor with the positive (+) mark on the circuit board as shown.



(✓) C35: 3.3 μF tantalum.

(✓) C29: 39 μF tantalum.

(✓) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 3-3

CONTINUE

(✓) Prepare the following wires:

One 3-1/4" black
One 3-1/4" red

NOTE: In the following steps, connect one end of each wire to the lettered side of the circuit board, solder the wires to the foil, and cut off the excess wire lengths.

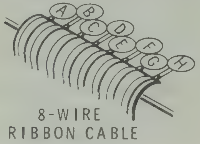
(✓) 3-1/4" black wire to hole J.

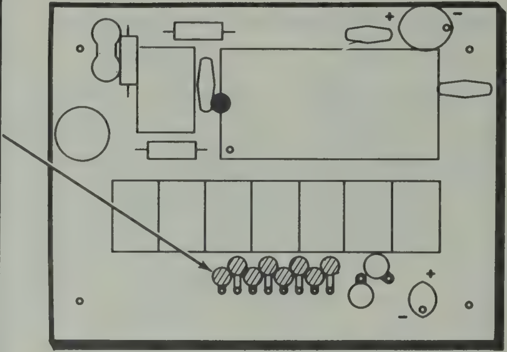
(✓) 3-1/4" red wire to hole K.

START

CAUTION: Do NOT allow the ends of the ribbon cable to be flexed more than necessary before or after you install it. Excessive flexing may break one or more pins.

(✓) 8-wire ribbon cable to holes A through H. Match the pins at either end of the cable with the corresponding row of holes from the lettered side of the circuit board. Be sure the cable is fully seated against the circuit board. Then solder all the pins to the bottom side of the circuit board and cut off the excess pin lengths.





PICTORIAL 3-4

CONTINUE

Circuit Board Checkout

Carefully inspect the circuit board for the following conditions.

( ) Unsoldered connections.

( ) Poor solder connections.

( ) Solder bridges between foil patterns.

( ) Protruding leads which could touch together.

( ) Tantalum capacitors for the correct position of the positive (+) or negative (−) lead.

INITIAL TESTS

You will now use an ohmmeter to make resistance checks on the circuit boards. This will tell you if a short or open circuit exists, which might cause problems when you apply power to the circuit boards. Do NOT install the IC's in their sockets on the circuit boards or apply power to them until any difficulty has been corrected.

To perform the following steps, you will need an ohmmeter that has a 1.5 volt test voltage. Most analog ohmmeters (VOM, VTVM) have this test voltage. In addition, it should have a center-scale deflection factor (number at the center of the scale) greater than 5, but less than 50. If such an ohmmeter is not available, make the resistance checks using the ohmmeter you have. Remember, however, that the readings you obtain may differ from the ones given in this section of your Manual.

NOTE: In the first set of the following tests, if you do not obtain the proper reading, reverse the ohmmeter test leads. (Some meters are wired differently than others). If you still do not get the proper reading, refer to "Initial Test Problems Chart" on Page 35.

CAUTION: In the following steps, use only the R × 10 or the R × 100 range of your ohmmeter. Other ranges may produce excessive current or may produce erroneously low readings.

Refer to Pictorial 4-1 (Illustration Booklet, Page 8) for the following steps.

(✓) Place the lever of TIME BASE switch SW3 in the .1 SEC position.

(✓) Place the lever of RANGE switch SW2 in the 50 MHz position.

( ) Connect the common (−) ohmmeter lead to the lead at T on the main circuit board.

Touch the input (+) ohmmeter lead to each of the two test points listed below. Make a check mark (✓) in one of the spaces provided as you make each check. You will use the remaining two check-off spaces later. NOTE: Allow sufficient time for any capacitor in the circuit to charge before you take a reading.

TEST POINT	READING: GREATER THAN
( ) ( ) C of Q11	1500 Ω
( ) ( ) E of Q11	500 Ω

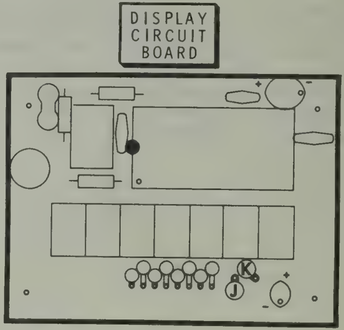
( ) Reverse the ohmmeter leads and touch each test point again.

TEST POINT	READING: GREATER THAN
( ) ( ) C of Q11	100 Ω
( ) ( ) E of Q11	200 Ω

(✓) Place the lever of RANGE switch SW2 in the 512 MHz position.

(✓) Repeat each of the previous four measurements. Make a check mark in the remaining space provided as you make each check.

(✓) Refer to Pictorial 4-2 and connect either ohmmeter lead to the black wire connected to hole J (ground) and the other lead to the red wire connected to hole K on the display circuit board. The ohmmeter must indicate infinity (∞).



PICTORIAL 4-2

INITIAL TESTS PROBLEMS CHART

If you cannot locate the problem on the circuit boards by referring to the following chart, proceed to "In Case of Difficulty" on Page 50. If a particular part is mentioned as a "Possible Cause of Low Readings" (Q11 for example), check that part to see if it was installed correctly. Also check it and the parts connected to it for poor connections.

PROBLEM	POSSIBLE CAUSE OF LOW READINGS
Improper reading at C of Q11.	1. Q11. 2. R26. 3. D14. 4. C12. 5. Solder bridge on +5V source line.
Improper reading at E of Q11.	1. Q11. 2. Solder bridge on +5V source line.
Improper reading at point K.	1. C29, C35, or C36.

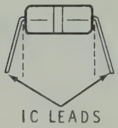
This completes the "Initial Tests." Proceed to "General Assembly and Wiring."

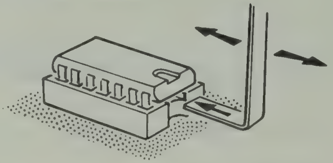
GENERAL ASSEMBLY AND WIRING

CAUTION: Integrated Circuits (IC's) are complex electronic devices that perform many complicated functions in the circuit. These devices can be damaged during installation. Read all of the following information before you install any IC's.

The pins on each IC are bent out at an angle, so they do not line up with the holes in the IC socket. Do NOT try to install an IC without first bending the pins as described below. To do so may damage the IC pins or the socket, causing intermittent contact.

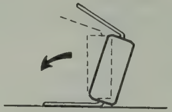
NOTE: An IC lifter has been furnished so you can remove an inline IC from its socket if this should be necessary.

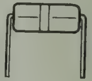




Push the shorter end of the lifter in between the IC and the socket and rock the longer portion back and forth. Be very careful, as the IC pins are very easily bent.

Before you install an IC, lay it down on its side as shown below and very carefully roll it toward the pins to bend the lower pins into line. Then turn the IC over and bend the pins on the other side in the same manner.





Make sure that the pin 1 end of the IC is positioned over the index mark on the circuit board. Refer to Detail 5-1A (Illustration Booklet, Page 10). Also, make sure that all of the pins are started into the socket. Then press the IC firmly into the socket. NOTE: An IC pin can become bent under the IC and it will appear as though it is correctly installed in the socket.

Refer to Pictorial 5-1 (Illustration Booklet, Page 9) for the following steps.

NOTE: In the following steps, when you install an IC, refer to Detail 5-1A (Illustration Booklet, Page 10), remove the IC from its packaging material (if necessary), and install the IC as shown.

(✓) U2: Install an SL952 IC (#442-698) at U2 on the main circuit board. Make sure the IC is fully seated. Then solder the pins to the foil and cut off the excess pin lengths.

(✓) U3: Install an SP8685B IC (#443-937) at U3 on the main circuit board.

(✓) U1: Install an MC10216 IC (#443-723) at U1 on the main circuit board.

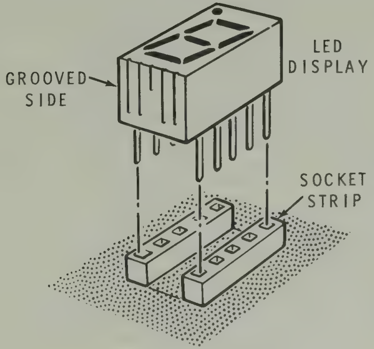
(✓) U4: Install an SN74S153 IC (#443-935) at U4 on the main circuit board.

(✓) U5: Install an SN74196 IC (#443-628) at U5 on the main circuit board.

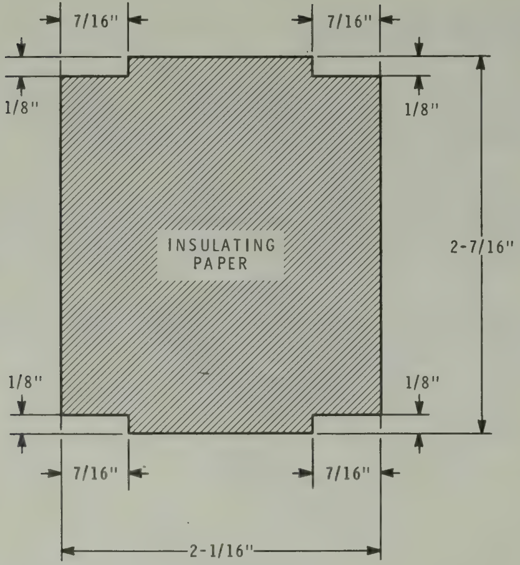
(✓) U6: Install an ICM7216D IC (#443-938) at U6 on the display circuit board.

(✓) V1: Refer to Detail 5-1B and notice the grooved side of the LED. Position the grooves up and install an LED in the socket strips at V1 on the display circuit board. Be sure the pins are straight and each pin goes into a socket strip hole.

(✓) V2-V7: Position the grooves up and install six LED's in the remaining pairs of socket strips on the display circuit board.



Detail 5-1B



Detail 5-2A

Refer to Pictorial 5-2 (Illustration Booklet, Page 10) for the following steps.

(✓) Refer to Detail 5-2A and prepare the insulating paper as shown. Use a pair of scissors or a sharp knife.

Refer to Detail 5-2B (Illustration Booklet, Page 11) for the next nine steps.

(✓) 1. Remove the backing paper from the insulating paper. Then press the paper onto the circuit board bracket as shown in the Pictorial.

(✓) 2. Mount a **4-40** × **3/8"** spacer at B on the component side of the main circuit board. Use a **4-40** × **3/16"** screw.

(✓) 3. Similarly, mount another **4-40** × **3/8"** spacer at C on the main circuit board.

NOTE: Use the nut starter to hold and start **4-40** nuts on screws.

(✓) 4. Loosely install a **4-40** × **1/4"** screw at each of the four corners of the circuit board bracket. Use a **large 4-40** nut at each location.

(✓) 5. Temporarily position the display circuit board over the four screws on the circuit board bracket. Then tighten each of the screws just enough to hold them in place. Reposition the hardware, as necessary, to allow the display circuit board to be removed. Finally, tighten all the hardware securely.

(✓) 6. Remove the display circuit board from the circuit board bracket.

(✓) 7. Place a piece of nonmetalized tape (supplied) over the free end of the black wire coming from hole N on the main circuit board. Then twist this wire and the wire coming from hole M together. Finally, position the wires between the two spacers on the main circuit board.

(✓) 8. Loosely install the circuit board bracket at spacers B and C on the main circuit board. Use two 4-40 × 3/16" screws and two #4 lockwashers. Center the bracket on the two spacers. Then tighten both screws.

(✓) 9. Position the display circuit board over the four screws on the circuit board bracket. Secure the circuit board with four small 4-40 nuts.

(✓) Match the pins at the free end of the 8-wire ribbon cable with the corresponding row of holes (A through H) on the component side of the main circuit board. Be sure the cable is fully seated against the circuit board and all the pins protrude through the circuit board. Then solder all the pins to the circuit board and cut off the excess pin lengths.

(✓) Locate the black and the red wires that are connected to holes J and K on the display circuit board. Twist these wires together approximately one turn per inch. Then connect and solder each of these wires to the main circuit board as follows:

Black wire to hole J.
Red wire to hole K.

(✓) Cut off the excess wire lengths on the nonlettered side of the main circuit board.

Refer to Pictorial 5-3 (Illustration Booklet, Page 12) for the following steps.

(✓) SW1: Refer to Detail 5-3A (Illustration Booklet, Page 13) and install the SPDT switch in the end panel. NOTE: The switch may be installed either way.

(✓) Place the input panel over the SPDT switch as shown in Detail 5-3A.

(✓) Refer to the inset drawing on Detail 5-3A and prepare two 3/8" solder lugs by forming them as shown. Use long-nose pliers.

(✓) J1: Refer again to Detail 5-3A and loosely mount a BNC jack at J1. Use the hardware supplied with the jack and a prepared 3/8" solder lug.

(✓) J3: Similarly, loosely mount the other BNC jack at J3.

(✓) Be sure the solder lugs at J1 and J3 are positioned as shown in Pictorial 5-3. Then tighten the hardware for BNC jacks J1 and J3.

(✓) Refer to inset drawing #1 on Pictorial 5-3 and press the power jack insulator into the power jack as shown.

(✓) Place the circuit board assembly in the case bottom as shown in Pictorial 5-3.

(✓) Line up the wider end of the end panel assembly with the corresponding groove in the case bottom. Then drop the assembly into the groove.

(✓) Make sure ON-OFF switch SW1 is in the OFF position as shown in inset drawing #2 on Pictorial 5-3.

NOTE: In the following steps "S-" with a number, such as (S-1) means to solder the connection. The number following the "S" tells how many wires are at the connection.

Connect the free end of each of the twisted black wires coming from holes M and N on the main circuit board as follows:

(✓) Taped black wire to switch SW1 lug 2 (S-1).

(✓) Other black wire to switch SW1 lug 3 (S-1).

(✓) Place the ferrite bead on the free end of capacitor C1.

Connect the free end of the leads coming from the main circuit board to the end panel assembly as follows:

IMPORTANT: To ensure that your completed frequency counter operates properly over its entire frequency range, it is very important that you keep the length of each lead in the following steps as short as possible. After you install each lead, cut off the excess lead lengths.

(✓) Lead from hole T to the solder lug at J3 (S-1).

(✓) Lead from hole S to jack J3 lug 1 (S-1). Wrap the end of the lead around the lug before you solder the connection.

(✓) Lead at the free end of capacitor C1 to jack J1 lug 1 (S-1). Wrap the end of the lead around the lug before you solder the connection.

(✓) Lead from hole L to the solder lug at J1 (S-1).

(✓) Connect the free end of the black wire coming from hole R on the main circuit board to the minus (−) battery lug. Do not put the batteries into the case bottom yet.

(✓) Connect the free end of the red wire coming from hole P on the main circuit board to the plus (+) battery lug.

(✓) Place the batteries into the case bottom and route the wires as shown. Bend the tabs as necessary to let the batteries fit properly in the case bottom.

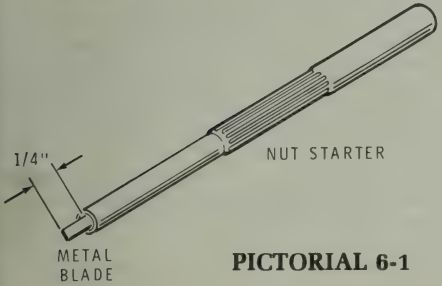
This completes "General Assembly and Wiring." Proceed to "Calibration".

CALIBRATION

The accuracy of your Frequency Counter depends to a great extent upon the care and accuracy with which you perform the calibration steps in this part of the Manual. If at any time you do not obtain the results called for in a step, refer to the "In Case of Difficulty" section to correct the problem.

PREPARATION

(✓) Refer to Pictorial 6-1 and push the 1" blade into the small end of the nut starter as shown. You will use this tool when you calibrate your Counter.



PICTORIAL 6-1

(✓) Make sure the Counter ON-OFF switch is in the OFF position.

( ) Connect the subminiature plug at the end of the battery charger cord to the Counter Power jack. Then connect the line cord on the battery charger/eliminator to the appropriate AC outlet.

NOTE:

1. Read the information under "Battery Charging" on Page 48 before you perform the next step.
2. This section of the Manual contains two calibration procedures. If you have access to a 50 MHz frequency counter and a signal generator (capable of delivering a 1-50 MHz, 25 mV output signal), or a laboratory standard proceed to the "Calibration With Instruments" procedures on Page 43. If these instruments are not available, use the following "Calibration Without Instruments" procedure.

CALIBRATION WITHOUT INSTRUMENTS

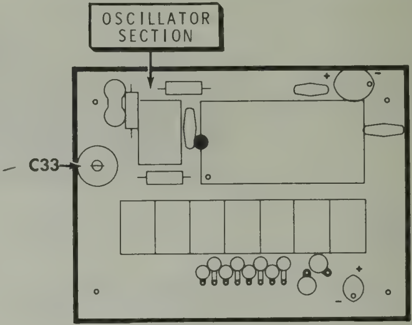
IMPORTANT: Most communications receivers and standard (AM) broadcast receivers, especially those with a built-in antenna coil, have sufficient sensitivity to produce the audible difference frequency ("beat frequency") called for in the following steps. However, if you are unable to hear the difference frequency, try another receiver before you assume there is a difficulty.

( ) Turn the Counter on and allow it to warm up for 30 minutes. This is MOST IMPORTANT for an accurate calibration.

In the following steps, you will calibrate your Counter by comparing (zero beating) its 10 MHz clock oscillator with an accurate frequency from a radio receiver. You can use either a general coverage communications receiver (Step 1) or an AM broadcast radio (Step 2) to receive this radio signal. Select one of the methods and calibrate your Counter, using either Step 1 or Step 2.

1. If you have a general coverage communications receiver, use its AM mode. For best accuracy, tune it to the highest WWV station frequency (25, 20, 15, 10 , or 5 MHz) that you can receive at a satisfactory volume level in your area. Temporarily connect an insulated, unshielded wire to the receiver antenna connector (leave the outside antenna connected to the receiver) and lay the wire over the oscillator section of your Counter in the area shown in Pictorial 6-2.

2. Tune in your AM broadcast radio to a station of medium volume and temporarily connect an additional antenna to the antenna connector of the radio. Then lay the antenna over the oscillator section of the Counter at the location shown in Pictorial 6-2. You can also use a portable AM broadcast radio by holding it so its antenna is close to the Counter oscillator section.



PICTORIAL 6-2

NOTE: The following step instructs you to adjust the trimmer in your Counter to obtain a zero-beat. To do this, slowly make the required adjustment in one direction and listen for a decrease in pitch and volume of the tone. If the pitch and volume seem to increase, make the adjustment in the opposite direction. The tone will go lower and lower in frequency and either disappear, or become only an intermittent growl. This is zero-beat.

( ) Insert the end of the calibration tool in the screw slot of trimmer capacitor C33. See Pictorial 6-2. Then turn the screw in the direction that produces a zero-beat. Carefully withdraw the calibration tool.

This completes the calibration of your Frequency Counter. Proceed to "Final Assembly."

CALIBRATION WITH INSTRUMENTS

With a Frequency Counter and Signal Generator

Refer to Pictorial 6-3 (Illustration Booklet, Page 14) for the following steps.

NOTE: The accuracy of your Counter, for this type calibration, depends on the accuracy of the test frequency counter.

( ) Connect the test cable of the test frequency counter to the output terminals of the signal generator.

( ) Connect a test cable from the 50 Hz/50 MHz input jack (J1) of your Counter to the output terminals of the signal generator.

( ) Place RANGE switch SW2 of your Counter in the 50 Hz/50MHz position.

( ) Place TIME BASE switch SW3 of your Counter in the 1.0 SEC position.

( ) Turn the Counter on and allow it to warm up for 30 minutes. This is MOST IMPORTANT for an accurate calibration.

( ) Set the signal generator to any convenient frequency between 1 MHz and 50 MHz at 250 mV to 500 mV output signal.

( ) Use the calibration tool to adjust trimmer capacitor C33 until your Counter indicates exactly the same frequency as the test frequency counter.

( ) Place the Counter ON-OFF switch in the OFF position.

( ) Disconnect the test frequency counter and the signal generator.

This completes the calibration of your Frequency Counter. Proceed to "Final Assembly."

With a Known Laboratory Standard Frequency

NOTE: It is essential that your known frequency source (frequency of your choice between 1 and 50 MHz) be absolutely stable. The accuracy of this type of calibration depends entirely on the accuracy of this known frequency.

( ) Connect a test cable from the 50 Hz/50 MHz input jack (J1) of your Counter to the Laboratory standard.

( ) Place RANGE switch SW2 of your Counter in the 50 Hz/50 MHz position.

( ) Place TIME BASE switch SW3 of your Counter in the 1.0 SEC position.

( ) Turn the Counter on and allow it to warm up for 30 minutes. This is MOST IMPORTANT for an accurate calibration.

( ) Use the calibration tool to adjust trimmer capacitor C33 until the laboratory standard frequency is exactly indicated on your Counter.

( ) Place the Counter ON-OFF switch in the OFF position.

( ) Disconnect the laboratory standard.

This completes the calibration of your Frequency Counter. Proceed to "Final Assembly."

FINAL ASSEMBLY

Refer to Pictorial 7-1 (Illustration Booklet, Page 15) for the following steps.

(✓) Refer to the inset drawing #1 on Pictorial 7-1 and carefully apply the function label to the case top. First peel away the protective backing paper from the label. Then press the label into place on the case top.

(✓) Carefully peel away the backing paper from the name plate. Then press the name plate into the recessed area in the upper right corner of the case top. See inset drawing #2 on Pictorial 7-1.

(✓) Carefully peel away the backing paper from the Caution label. Then press the label into the recessed area in the case bottom. See inset drawing #3 on Pictorial 7-1.

(✓) Peel away the backing paper from only one side of two foam gaskets. Then press each gasket to the inside of the case top at the locations shown.

NOTE: The blue and white label that you will install in the following step shows the Model number and Production Series number of your kit. Refer to these numbers in any communications you have with the Heath Company about this kit.

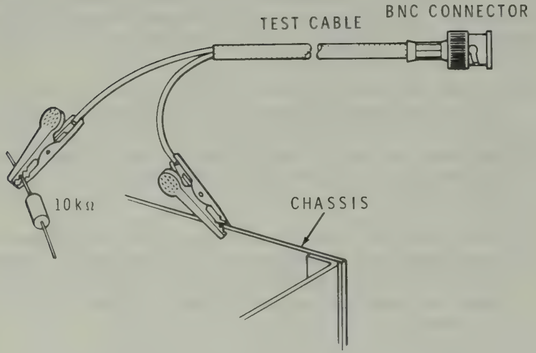
(✓) Carefully peel away the paper backing from the blue and white label. Then press the label to the inside of the case top at the location shown.

(✓) Position the case top over the case bottom as shown in the Pictorial. Then press the case halves together and secure them with three #6 × 5/8" self-tapping screws.

( ) Install the bail in the recessed area in the case bottom by first pressing the open end of the bail slightly together with one hand. Line up each end of the bail with respective holes G and H in the case bottom. Then release the pressure on the bail. Finally, push the bail so it pivots into the recessed area and is held in place by the catch.

This completes the Assembly of your Frequency Counter.

OPERATION



PICTORIAL 8-1

INPUTS

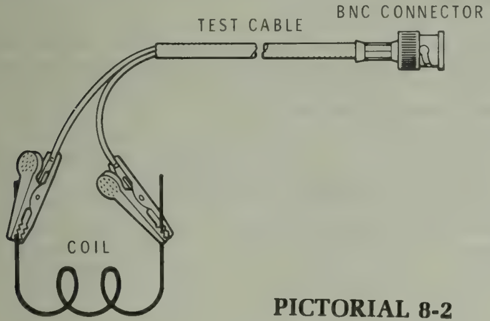
The 50 Hz/50 MHz input has an input impedance of 1 MΩ that is shunted by approximately 18 pF. When you measure high amplitude and fast rise time pulses or square waves (amplitude ⩾ 200 mV and rise time ⩽ 50 nS), connect a 1/4-watt resistor (approximately 10 kΩ) in series with the test cable (see Pictorial 8-1) to eliminate capacitive loading and reflections in the test cable.

These reflections would distort the waveform, and this could cause erroneous readings-or possibly damage the equipment under test. Capacitive loading can also cause erroneous readings by changing the frequency of the unit under test readings.

A simple way to reduce reflections and capacitive loading is to use a 10 MΩ, divide-by-10 oscilloscope probe. This decreases the input sensitivity somewhat, but does provide isolation between the unit under test and your Frequency Counter.

When you measure frequencies from a transmitter with a power greater than 1/2-watt, use a coupling coil in place of a direct connection. Three turns of a hookup wire connected to the end of the test cable, as shown in Pictorial 8-2, will provide enough signal to trigger the Counter. Place the coil just close enough to the signal source for the Counter to count. **NOTE: Do NOT connect the ground to the transmitter and place the coil in the same axis as the transmitter coil or around the antenna.**

The 40 MHz/512 MHz input has an input impedance of 50 ohms; and therefore, will properly terminate a 50-ohm transmission line. If you use test cables other than 50 ohms, it will be necessary to use a matching pad to eliminate reflections and capacitive loading.



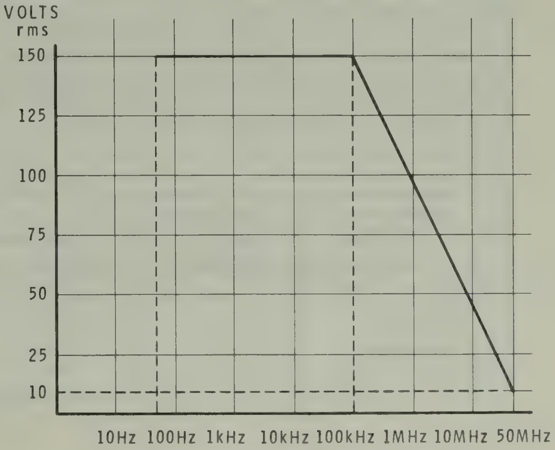
PICTORIAL 8-2

Optional Antenna

If you have purchased the Model IMA-2400-1 Telescopic Antenna, you may shorten or lengthen this collapsible antenna as necessary to provide optimum pickup when it is connected to the Counter. Merely connect the antenna connector to the desired input jack; then adjust the length of the antenna as necessary for best results.

MAXIMUM INPUT VOLTAGE

The 50 Hz/50 MHz input can withstand 150 volts rms up to 100 kHz. Above this frequency, the maximum input voltage must be derated according to the following graph.



50 Hz/50 MHz MAXIMUM INPUT VOLTAGE DERATING GRAPH

The 40 MHz/512 MHz input is protected to 5 volts rms throughout its frequency range.

THE DISPLAY

You can use this Counter to measure any frequency between 50 Hz and 512 MHz. Connect the equipment under test to the appropriate input jack and read the frequency from the display.

The TIME BASE switch selects the reference time (gate time) over which the counting circuitry makes its measurement, and thus, selects the resolution of the display. The following chart gives the resolution you will obtain with the various settings of TIME BASE and RANGE switches.

FREQUENCY RANGE	TIME BASE SWITCH POSITION	RESOLUTION
50 Hz/50 MHz	1.0 SEC	10 Hz
50 Hz/50 MHz	.1 SEC	100 Hz
40 MHz/512 MHz	1.0 SEC	100 Hz
40 MHz/512 MHz	.1 SEC	1 kHz

BATTERY CHARGING

Either of the two optional battery chargers supply about 50 mA of current to the battery pack when it is being charged (with the Counter turned off). The charger limits the current to a safe value so the batteries can never be overcharged.

Under normal operation, the batteries will last 1 to 1-1/2 hours on a full charge. Charge the batteries from 14 to 24 hours to obtain a full charge.

Additional Information

The battery cells in your Counter are rated at 500 mAh. This means that if the five-cell pack is drained at 500 mA for one hour, the voltage would still be at or above five volts. Five volts (or 1 volt per cell) is considered the end point and marks the point at which the "internal impedance" of the battery begins to increase greatly. Below five volts, the clock oscillator may stop running. If so, a single digit may light very brightly. Do NOT let this condition persist, as damage to this display digit may result.

Ni-Cad (nickel-cadmium) batteries are not immortal. However, with reasonable care, they should provide a good service life for your Counter. Any of the following three conditions may reduce the life of a Ni-Cad battery:

Sustained overcharging heat

Cell reversal

Memory

Sustained overcharging heat is eliminated as long as you use one of the two battery charger/eliminator accessories available for this kit. These accessories have been designed to prevent overcharging of the battery cells.

Cell reversal takes place when one of the cells in the battery is completely discharged (zero volts). The remaining cells then force a current through the discharged cell; this causes the voltage across the cell to reverse and begins to destroy the cell chemistry. To avoid this condition, make sure you do not discharge the battery pack below five volts. If you feel a battery has gone bad, a simple voltmeter test, measuring the voltage across each cell, will usually turn up the defective cell. It is usually best to run the Counter for half an hour after a charge cycle and then examine each cell and replace the defective ones. Typical voltages are:

1.38 volts maximum at charge time.

1.25 volts typical during discharge.

1.0 volt end point.

Memory causes an apparent shortening of the battery capacity by reducing the typical voltage, during the discharge cycle, down to one volt in a few minutes of operation. It occurs when a Ni-Cad cell is consistently exercised only ten percent of its full capacity and then recharged.

You can reverse memory with a series of full, charge/discharge cycles. The battery pack will normally improve after each cycle. It may not be a bad idea, after you complete your initial testing, to run the battery pack down and then recharge to get off to a good start.

Since the charging efficiency for a Ni-Cad cell is approximately 66%, and your charger will typically provide 50 mA of current, it will take about 19 hours to totally recharge a completely discharged battery pack.

While a Ni-Cad battery system is not ideal, it is the best system currently available for battery-powered test equipment like your Frequency Counter. These battery cells can and will take a lot of abuse; and if you avoid overdischarging and overcharging, they will give you many dependable recycles.

IN CASE OF DIFFICULTY

This section of the Manual is divided into three parts. The first part, titled "General Troubleshooting Information," describes what to do about the difficulties that may occur right after your Frequency Counter is Assembled.

The second section titled "Troubleshooting Precautions," points out the care that is required when you service the Frequency Counter to prevent damage to the components.

NOTE: It is important that you read the entire "General Troubleshooting Information" and "Troubleshooting Precautions" sections, which follow, before you attempt to service your Frequency Counter.

The third part, titled "Troubleshooting Charts," is provided to assist you in servicing the Frequency Counter if the "General Troubleshooting Information" fails to clear up the problem, or if difficulties occur after your Frequency Counter has been in use for some time. The "Troubleshooting Charts" list a number of possible difficulties that could arise along with several possible solutions to those difficulties. Refer to the "Circuit Board X-Ray Views" on Pages 59 and 60 for the physical location of parts on the circuit boards.

GENERAL TROUBLESHOOTING INFORMATION

CAUTION: Always be sure the foil side of each circuit board is on an insulated surface; otherwise, the Frequency Counter can be damaged.

1. Recheck the wiring. It is often helpful to have a friend check your work. Someone who is not familiar with the unit may notice an error that was consistently overlooked by the builder.

2. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, you can eliminate may troubles by checking all connections to make sure that they are soldered correctly. Reheat the connections, if necessary, but be careful so you do not create any solder bridges.

3. Check the values of all the parts. Be sure that the proper part has been installed at each location on the circuit boards. Refer to the "Circuit Board X-Ray Views" for the physical location of parts on the circuit boards.

4. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the components on the circuit boards.

5. Check very carefully to be sure that there are no solder bridges between different circuit board foils. If you are not sure if a solder bridge exists, compare the circuit board foil with the "Circuit Board X-Ray Views" on Pages 59 and 60 in this Manual. Remove any solder bridges by holding a clean, hot soldering iron tip between the two points that are bridged until the excess solder flows down onto the tip.

If you still cannot locate and correct the trouble after you have completed the checks listed above, and if a voltmeter is available, check the voltages in the Frequency Counter against those shown on the Schematic. A review of the "Circuit Description" and Schematic may also help you to locate any difficulties in the kit.

In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of this Manual. Your Warranty is located inside the front cover.

TROUBLESHOOTING PRECAUTIONS

- Be sure you do not short any adjacent terminals or foils when you make tests or voltage measurements. If a probe or test lead slips, for example, and shorts together two adjacent connections, it is very likely to cause damage to one or more IC's, transistors, or diodes.

- Be especially careful when you test any circuit that contains an IC or a transistor. Although these components have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than many other parts.

- In several areas of each circuit board, the foil patterns are quite narrow. When you unsolder a part to check or replace it, avoid excessive heat while you remove the part. A suction-type desoldering tool will make removal considerably easier. You may also use the desoldering braid supplied with this kit to remove the solder.

Troubleshooting Chart

This chart lists the condition and possible causes of several malfunctions. If a particular part is mentioned (U6 for example) as a possible cause, check that part to see if it was installed correctly. Also check it and the parts connected to it for poor connections. It is also possible, on rare occasions, for a part to be faulty and require replacement.

PROBLEM	POSSIBLE CAUSE
1. No part of the display lights.	A. Dead batteries. B. SW1. C. J2. D. D14. E. Q11. F. U6. G. Open wiring to batteries.
2. One or more display segments do not light.	A. V1-V7. B. U6.
3. One or more digits do not light.	A. U6.
4. Improper decimal point operation.	A. Q7-Q9. B. U4, U6. C. V1-V7.
5. +5 volt supply voltage is too high.	A. D14. B. Q11.

SPECIFICATIONS

INPUTS

Frequency Range	50 Hz to 50 MHz	40 MHz to 512 MHz
Sensitivity	25 mV rms guaranteed 10 mV rms typical	25 mV rms guaranteed 10 mV rms typical
Input Impedance	1 MΩ shunted by < 24 pF	50 Ω
Input Protection	150V rms to 100 kHz, derating to 10 V rms at 50 MHz	5V rms

TIME BASE

Frequency	10 MHz.
Setability	±1 PPM.
Temperature Stability	±10 PPM, 0° C to 40° C.

GENERAL

Gate Time	1 second or .1 second (switch selected).
Power Requirements	Five 1.2 V nickel-cadmium batteries or external battery charger/eliminator.
Dimensions (overall)	1-5/8″ H × 3-3/8″ W × 8-3/8″ L (4.1 × 8.6 × 21.3 cm).
Weight	13 oz. (370 g) with batteries.

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

CIRCUIT DESCRIPTION

This Circuit Description is divided into two sections; "Theory of Operation" and "Individual Circuits." The Theory of Operation section briefly describes overall instrument operation in block diagram format. The Individual Circuits section examines all of the circuit components and their interrelationship. Before you read the Individual Circuits, read the Theory of Operation section. This will help you put the individual circuit components into perspective.

While you read this Circuit Description, refer to the Block Diagram and the Schematic Diagram (fold-in).

Theory of Operation

SIGNAL INPUTS

Two separate inputs are provided to accomodate the input signals. The 50 MHz amplifier consists of a protected FET/bipolar pair and a 3-stage IC (integrated circuit) amplifier. The 512 MHz amplifier is a high gain, wideband IC amplifier with a 50-ohm input impedance. Its output is prescaled by a factor of 10 (÷10).

FREQUENCY MEASUREMENT

50 MHz Counter

When you select the 50 MHz input, the input signal is routed through multiplexer U4 to first decade counter U5, where it is divided by 10. This signal is then applied to U6 (the heart of the counter), which is actually a complete 10 MHz frequency counter. This is a CMOS/LSI* integrated circuit which contains all the gating, mode selection, time base, and digit driving circuitry.

512 MHz Counter

When you select the 512 MHz input, the signal is routed from the output of the pre-scaler, through multiplexer U4 (the gate control circuit), to first decade counter U5 where the signal is divided by 10. The remaining signal flow is identical to that described for the 50 MHz counter.

* Complementary Metal-Oxide Semiconductor/Large Scale Integration

Individual Circuits

LOGIC CIRCUITS

Three types of integrated circuit (IC) logic are used in this instrument. It is important that you know the nominal voltage parameters for each type of logic to understand instrument operation. TTL, CMOS, and ECL logic all use a +5 volts supply voltage in this instrument.

Exact voltage levels are as follows:

TTL logic high (input): greater than +2.0 volts.

TTL logic high (output): greater than +2.4 volts.

TTL logic low (input): less than +.8 volt.

TTL logic low (output): less than +.4 volt.

CMOS logic high (input): greater than +3.0 volts.

CMOS logic high (output): greater than +4.5 volts.

CMOS logic low (input): less than +2.0 volts.

CMOS logic low (output): less than +.5 volt.

ECL logic high (input): +4.25 volts minimum.

ECL logic high (output): +4.25 volts minimum.

ECL logic low (input): +3.5 volts maximum.

ECL logic low (output): +3.5 volts maximum.

50 MHz INPUT AMPLIFIER

The input signal is coupled from jack J1 to the gate (G) of FET Q1, a source follower. Resistor R2 limits the low frequency current (input protection) to clamping diodes D1 and D2. Capacitor C2 is a high frequency bypass element. FET Q1 and transistor Q2, an emitter follower, translate the high input impedance to the low drive impedance required by U1. The voltage gain of this pair of transistors is approximately .7.

The output from the collector (C) of Q2 is AC coupled to pin 4 of U1, a 3-stage differential amplifier with an internal voltage reference source. The first two stages provide a total voltage gain of approximately 24 dB. The third stage uses positive feedback to form a Schmitt trigger with an input hysteresis of approximately 330 mV peak-to-peak. This converts the amplified input signal into a fast-rise rectangular wave of proper amplitude to drive the ECL logic used in measuring the frequency. Transistor Q3 translates the ECL logic levels from U1 to TTL logic levels. These levels are applied to emitter follower Q4, which simply buffers Q3 and provides driving capability for U4.

512 MHz INPUT AMPLIFIER

The input signal is coupled from jack J3, through capacitor C13, to the diode bridge. This diode bridge is made up of four hot-carrier (Schottky barrier) diodes, D5 through D8. This circuit, which provides soft limiting of the input signal, limits at approximately 300 mV peak-to-peak. As the input signal increases above this level, the current through each bridge diode decreases. Finally, the only element that couples the signal to the input of U2 (at pin 10) is the diode capacitance. The coupling due to this capacitance is quite significant at 500 MHz. U2 is an ECL compatible, wide-band, differential preamplifier with a voltage gain of 20-30 dB. This amplifier is capable of delivering output signals that are self-limiting at 1 volt peak-to-peak.

The other input (pin 11) of the differential amplifier is referenced to ground. One of the outputs of U2 (pin 3) is coupled through capacitors C21 and C23 to the input of divide-by-10 prescaler U3. The other output (pin 4) of U2 is loaded to ground by capacitor C22 and resistors R33 and R34 in order to keep the amplifier balanced. The output (pin 2) of U3 is converted from ECL levels to TTL levels by transistor Q5. These levels are applied to emitter follower Q6, which acts as a buffer for Q5. Q6 also provides driving capability for U4.

INPUT SELECTION

With Range switch SW2 in the 50 MHz position, the entire 512 MHz amplifier section is disconnected from the power supply. One section of multiplexer U4 then transfers the signal at the emitter (E) of transistor Q4 to first decade counter U5, where the signal is divided by 10. The signals at the Q_C and Q_D outputs of U5 are OR'ed by diodes D12 and D13 to form a signal with a 60/40 duty cycle. This signal is then applied to input A (pin 28) of 10 MHz frequency counter U6.

With Range switch SW2 in the 512 MHz position, the entire 50 MHz amplifier section is disconnected from the power supply. One section of multiplexer U4 transfers the signal at the emitter (E) of transistor Q6 to first decade counter U5. As with the 50 MHz amplifier section, the signal from U5 is applied to input A of U6.

10 MHz FREQUENCY COUNTER

Integrated circuit U6 combines a high frequency oscillator, a decade time-base counter, an 8-decade data counter and latches, a 7-segment decoder, digit multiplexers, and 8-segment and 8-digit drivers which drive the LED display.

Crystal Y1 and its associated components determine the operating frequency (10 MHz) of the on-chip oscillator. Capacitor C33 is variable to permit precise calibration of the oscillator. Resistor R51 provides proper biasing.

Switch SW3 selects accumulation times of either 1 second or .1 second. With a 1 second accumulation time, the frequency can be displayed to a resolution of 10 Hz in the least significant digit.

DECIMAL POINT SELECTION

As previously stated, one half of integrated circuit U4 determines which input signal is transferred to first decade counter U5. The other half of U4 selects the proper decimal point. Synchronized clocking signals are applied to U4 from U6 via transistors Q7 through Q9.

POWER SUPPLY

Power for the Counter may come from the internal, 5-cell, 6-volt, nickel-cadmium battery, or from the battery charger. This charger provides power for the Counter while it charges the internal battery.

Transistor Q11 forms a simple, series-type, pass transistor, with zener diode D14 determining the output voltage of approximately 5 volts.

Resistor R25 limits the current supplied by the battery charger to the battery.

CIRCUIT BOARD X-RAY VIEWS

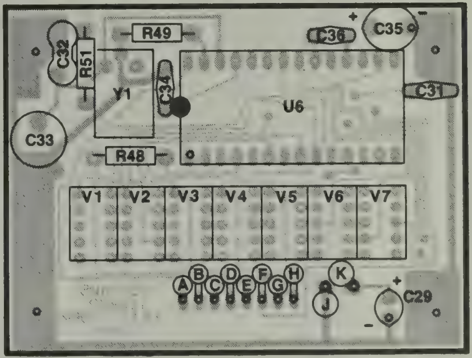
NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

A. Find the circuit component number (R5, C3, etc.) on the X-Ray View.

B. Locate this same number in the "Circuit Component Number" column of the "Parts List" in the front of this Manual.

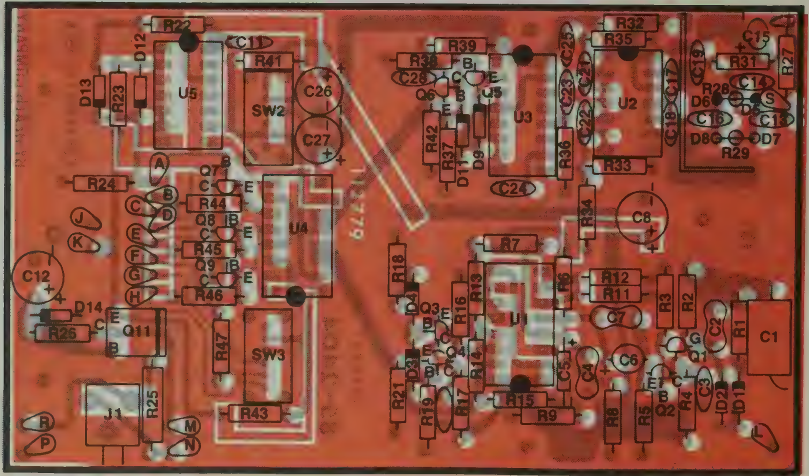
C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.

DISPLAY CIRCUIT BOARD



(Viewed from the component side)

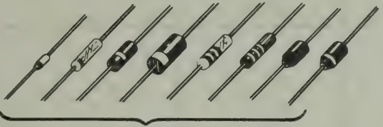
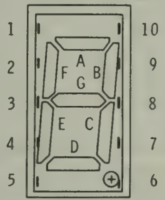
MAIN CIRCUIT BOARD



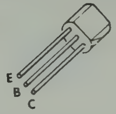
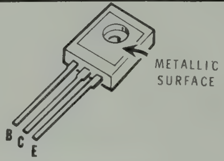
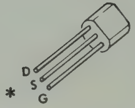
(Viewed from the component side)

SEMICONDUCTOR IDENTIFICATION CHARTS

DIODES

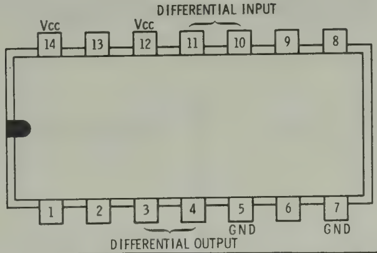
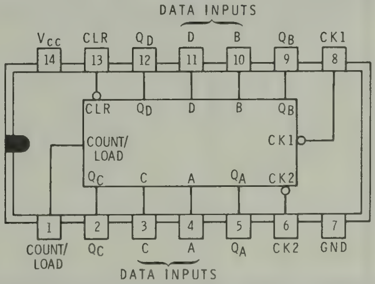
CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
D3, D4, D9 D11, D12, D13	56-56	1N4149	IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.  BANDED END (CATHODE)
D1, D2	56-86	FD777	
D5, D6 D7, D8	56-87	FH1100	
D14	56-616	1N5232	
V1, V2 V3, V4 V5, V6 V7	411-825	FND5141 or FND367 code 11 or 12 only	TOP VIEW  1 2 3 4 5 10 9 8 7 6 A F B G E C D Pin 1....Common Cathode 2....Segment F 3....Segment G 4....Segment E 5....Segment D 6....Common Cathode 7....Decimal Point 8....Segment C 9....Segment B 10...Segment A

TRANSISTORS

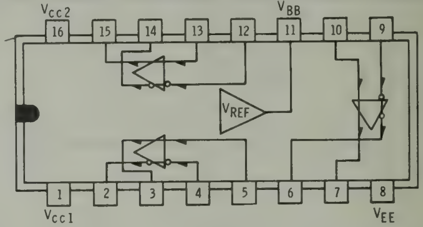
CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
Q3, Q5	417-292	2N5771	
Q2, Q4, Q6	417-293	2N5770	
Q7, Q8, Q9	417-881	MPSA13	
Q11	417-818	MJE181	
Q1	417-828	Selected E304	

*Due to the nature of an FET, the drain and source leads may be interchanged in some circuits.

INTEGRATED CIRCUITS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U2	442-698	SL952	 DIFFERENTIAL INPUT Vcc 14 13 Vcc 12 11 10 9 8 1 2 3 4 5 GND 6 7 GND DIFFERENTIAL OUTPUT
U5	443-628	SN74196	 DATA INPUTS Vcc CLR Q_D D B Q_B CK1 14 13 12 11 10 9 8 CLR Q_D D B Q_B COUNT/ LOAD CK1 Q_C C A Q_A CK2 1 2 3 4 5 6 7 COUNT/ LOAD Q_C C A Q_A CK2 GND DATA INPUTS

Integrated Circuits (cont'd.)

<table>
<tr><th>CIRCUIT COMPONENT NUMBER</th><th>HEATH PART NUMBER</th><th>MAY BE REPLACED WITH</th><th>IDENTIFICATION (TOP VIEW)</th></tr>
<tr><td>U1</td><td>443-723</td><td>MC10216L</td><td>
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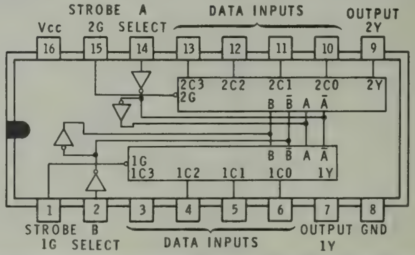
<tr><td>U4</td><td>443-935</td><td>SN74S153</td><td>
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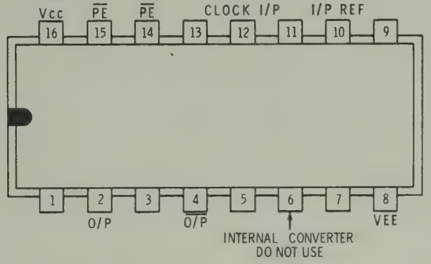
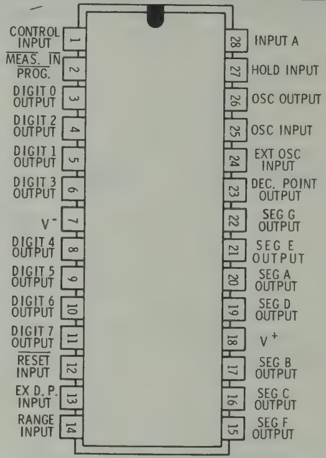
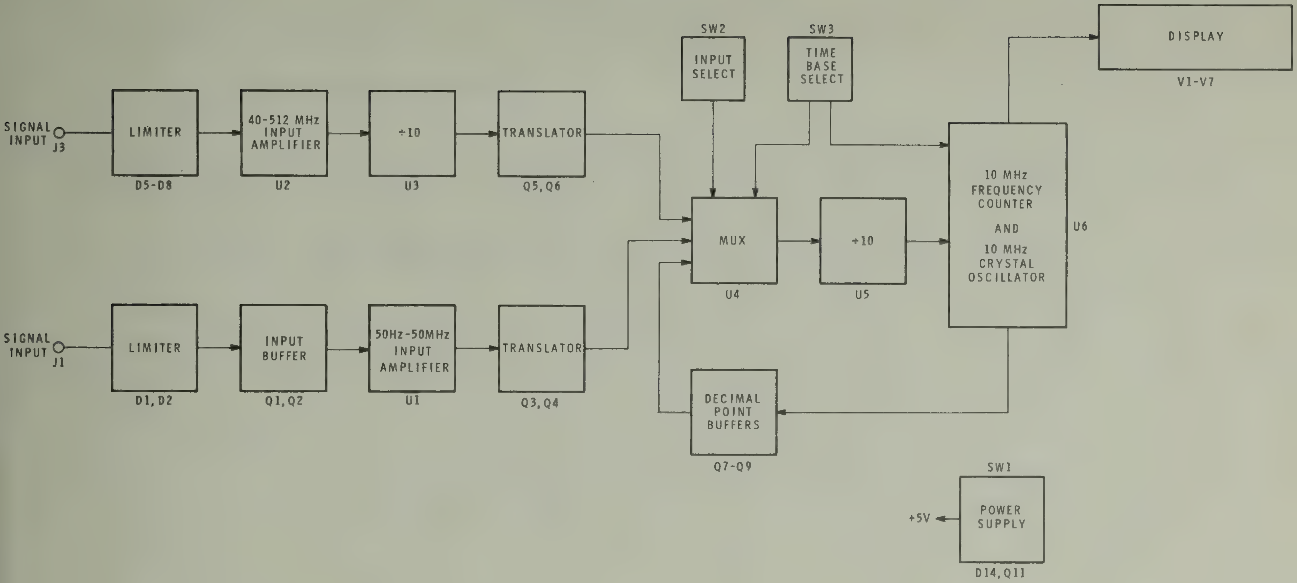
Integrated Circuits (cont'd.)

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U3	443-937	SP8685B	 Vcc $\overline{\text{PE}}$ $\overline{\text{PE}}$ CLOCK I/P I/P REF 16 15 14 13 12 11 10 9 1 2 3 4 5 6 7 8 O/P $\overline{\text{O/P}}$ INTERNAL CONVERTER DO NOT USE VEE

Integrated Circuits (cont'd.)

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U6	443-938	ICM7216D	



BLOCK DIAGRAM

HEATH ZENITH
HEATH COMPANY • BENTON HARBOR, MICHIGAN 49022
TLX 72-9421

IMPORTANT NOTICE

Please make the following changes in your IM-2400 Assembly Manual before you start to assemble your kit.

Page 9 — Under "Miscellaneous." Change the Main circuit board Part No. from 85-2404-2 to 85-2404-1.

OK

Page 15 — Left column. Add the following sentence to the third step:

NOTE: The circuit board may be marked "47" at this location.

Page 30 — Right column. Add the following step just before the last step:

( ) Locate the foam strip. Then cut it into two 3/8″ pieces. Use these pieces in the following step.

Thank you,

HEATH COMPANY

IM-2400/595-2382
591-3303

Heathkit® P-0

BK - 0
BN - 1
R - 2
O - 3
Y - 4
G - 5
BL - 6
V - 7
G - 8
W - 9

~~N8BZF - JOHN~~

AJ8K - TOM

CUSTOMER SERVICE

REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath Electronic Centers. Be certain to include the **HEATH** part number exactly as it appears in the parts list.

ORDERING FROM THE FACTORY

Print all of the information requested on the parts order form furnished with this product and mail it to Heath. For telephone orders (parts only) dial 616 982-3571. If you are unable to locate an order form, write us a letter or card including:

- Heath part number.
- Model number.
- Date of purchase.
- Location purchased or invoice number.
- Nature of the defect.
- Your payment or authorization for COD shipment of parts not covered by warranty.

Mail letters to:
Heath Company
Benton Harbor
MI 49022
Attn: Parts Replacement

Retain original parts until you receive replacements. Parts that should be returned to the factory will be listed on your packing slip.

OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath Electronic Centers listed in your catalog. Be sure to bring in the original part and purchase invoice when you request a warranty replacement from a Heath Electronic Center.

TECHNICAL CONSULTATION

Need help with your kit? — Self-Service? — Construction? — Operation? — Call or write for assistance. you'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek — please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase and invoice number.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit COD for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment. Do not include the kit Manual.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH ZENITH

HEATH COMPANY • BENTON HARBOR, MICHIGAN

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

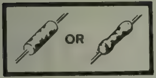
LITHO IN U.S.A.

ILLUSTRATION BOOKLET

Part of 595-2382

PARTS PICTORIAL

A1



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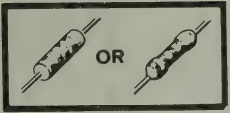

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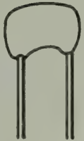

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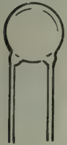

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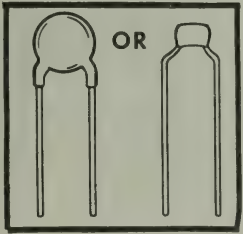

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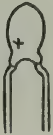

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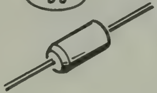

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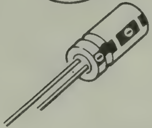

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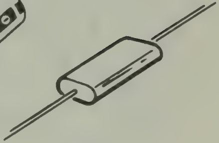

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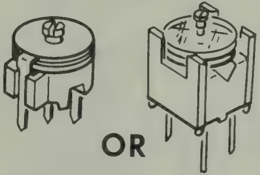

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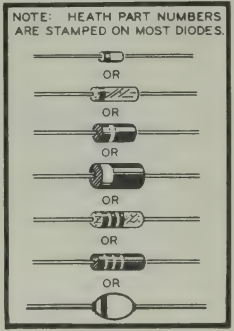

NOTE: HEATH PART NUMBERS ARE STAMPED ON MOST DIODES.

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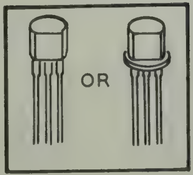

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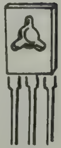

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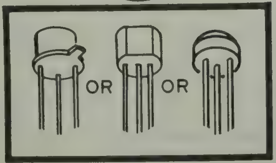

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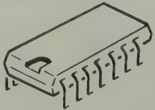

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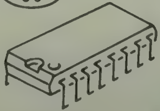

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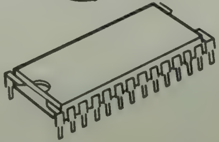

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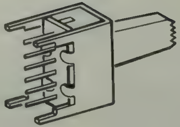

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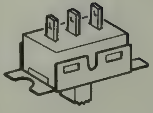

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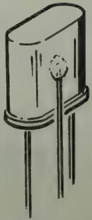

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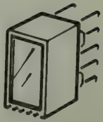

D5

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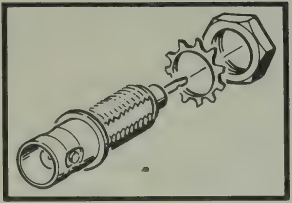

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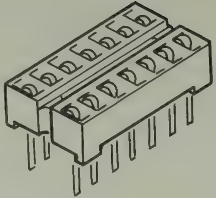
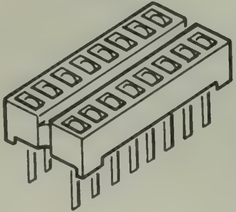
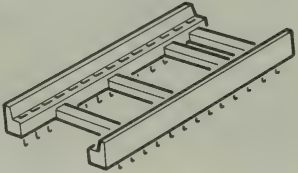


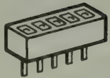
E3



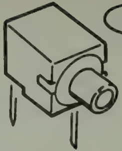
E4



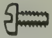
E5



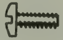
E6



F1



F2

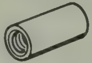


F3

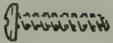
F4

F5

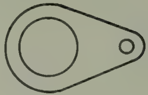
F6

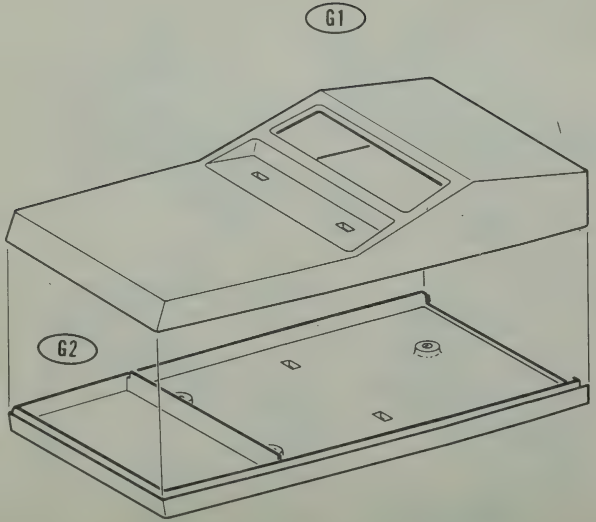


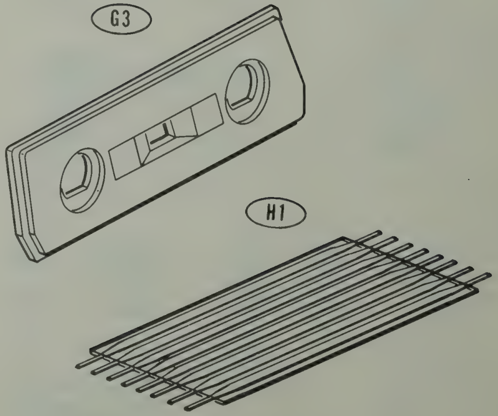
F7

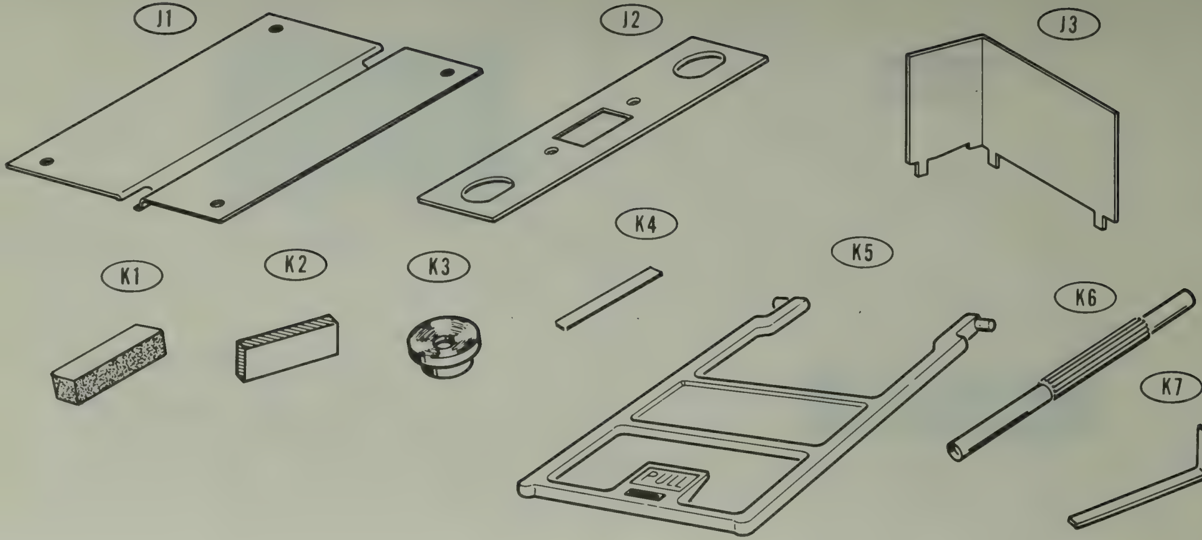


F8

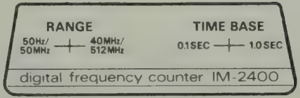



G1
G2

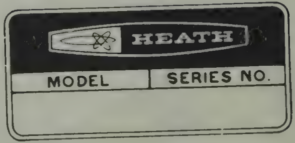

G3
H1


J1
J2
J3
K1
K2
K3
K4
K5
K6
K7
PULL

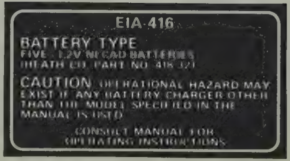
L1



L3



L2

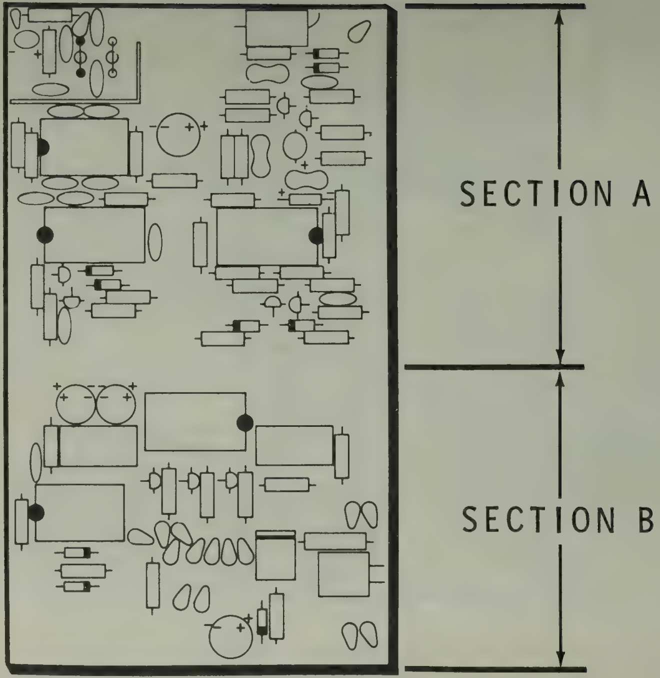

EIA-416

BATTERY TYPE
FIVE 1.2V NI-CAD BATTERIES
(HEATH CO. PART NO. 418-32)

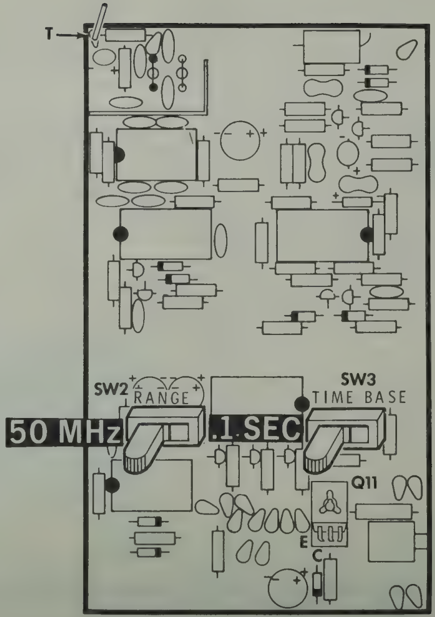
CAUTION: OPERATIONAL HAZARD MAY EXIST IF ANY BATTERY CHARGER OTHER THAN THE MODEL SPECIFIED IN THE MANUAL IS USED.

CONSULT MANUAL FOR
OPERATING INSTRUCTIONS

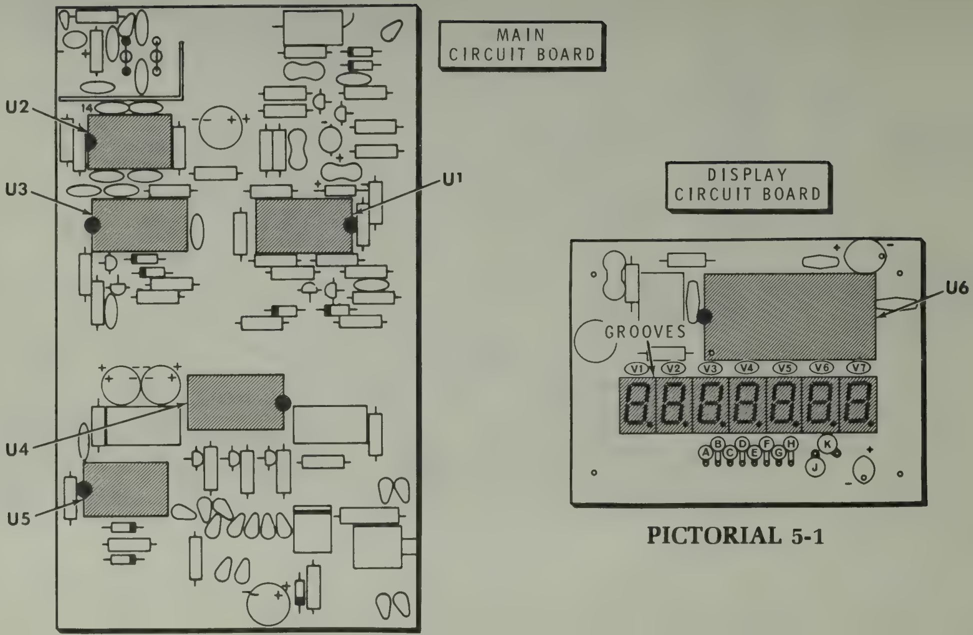
L4



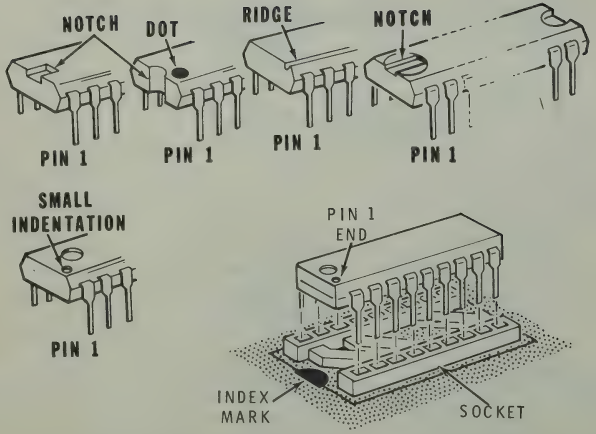
PICTORIAL 2-1



PICTORIAL 4-1

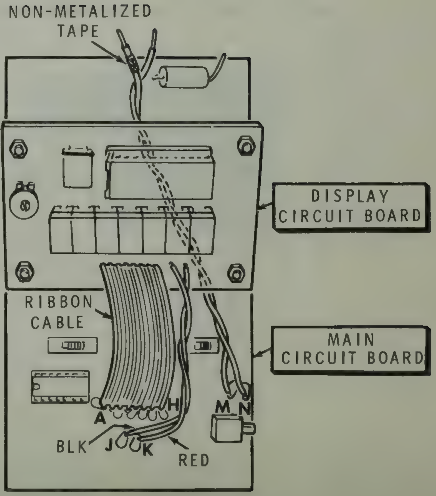


PICTORIAL 5-1

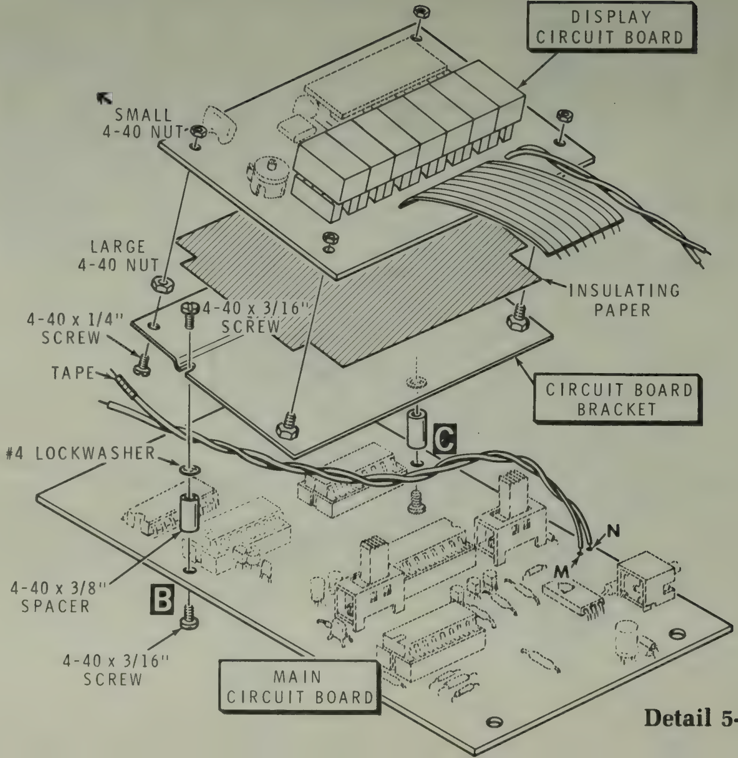


AFTER THE PINS ARE STRAIGHTENED, POSITION THE PIN 1 END OF THE IC AT THE END OF THE SOCKET WHERE THE INDEX MARK IS SCREENED ON THE CIRCUIT BOARD. THEN INSERT THE IC PINS INTO THE SOCKET AND PUSH THE IC DOWN INTO PLACE. BE SURE YOU DO NOT BEND OVER ANY IC PINS. THIS IS VERY EASY TO DO.

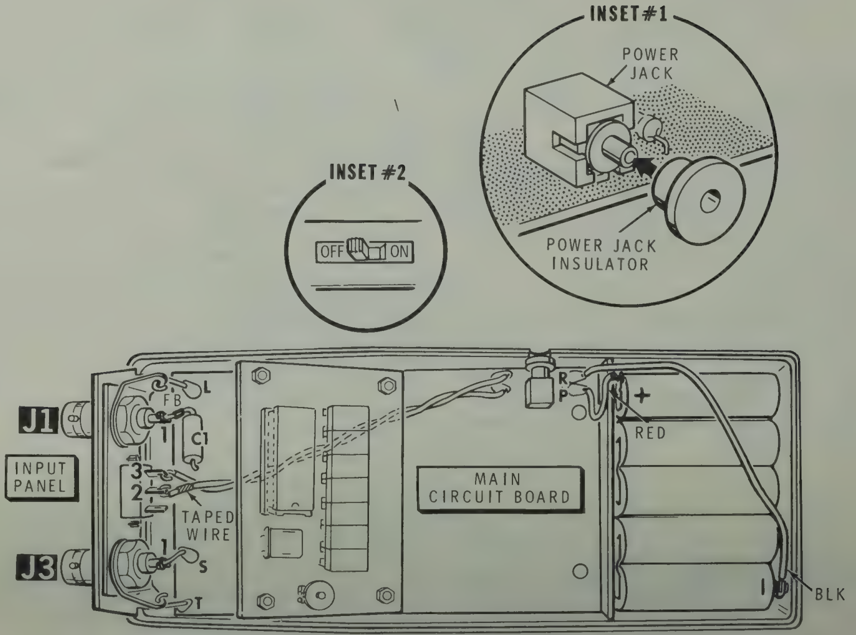
Detail 5-1A



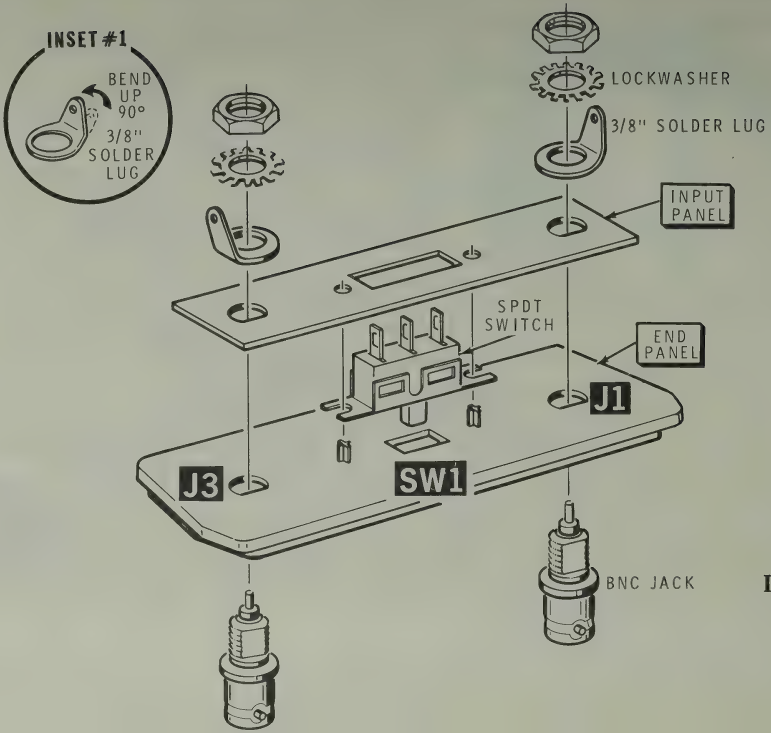
PICTORIAL 5-2


DISPLAY CIRCUIT BOARD
SMALL 4-40 NUT
LARGE 4-40 NUT
INSULATING PAPER
4-40 x 1/4" SCREW
4-40 x 3/16" SCREW
TAPE
CIRCUIT BOARD BRACKET
C
#4 LOCKWASHER
N
M
4-40 x 3/8" SPACER
B
4-40 x 3/16" SCREW
MAIN CIRCUIT BOARD

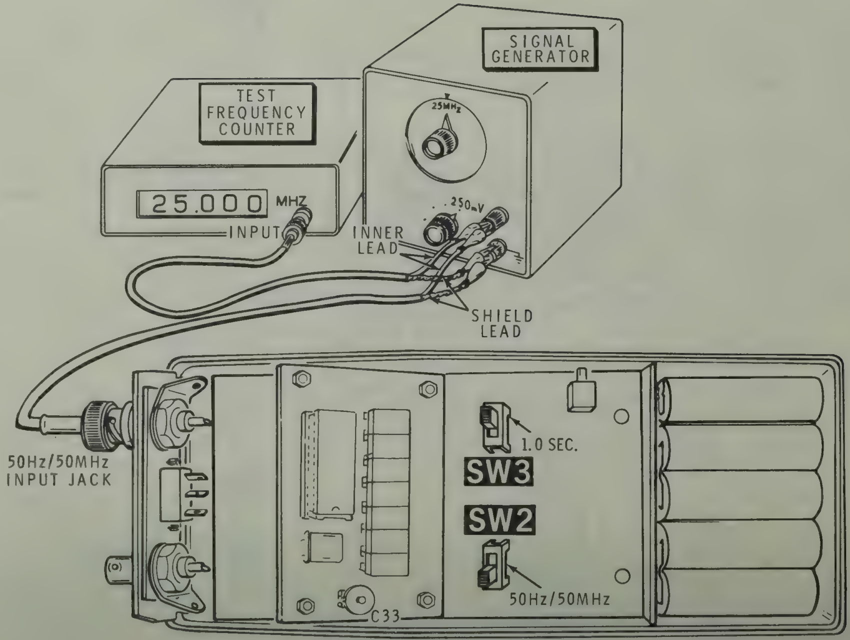
Detail 5-2B



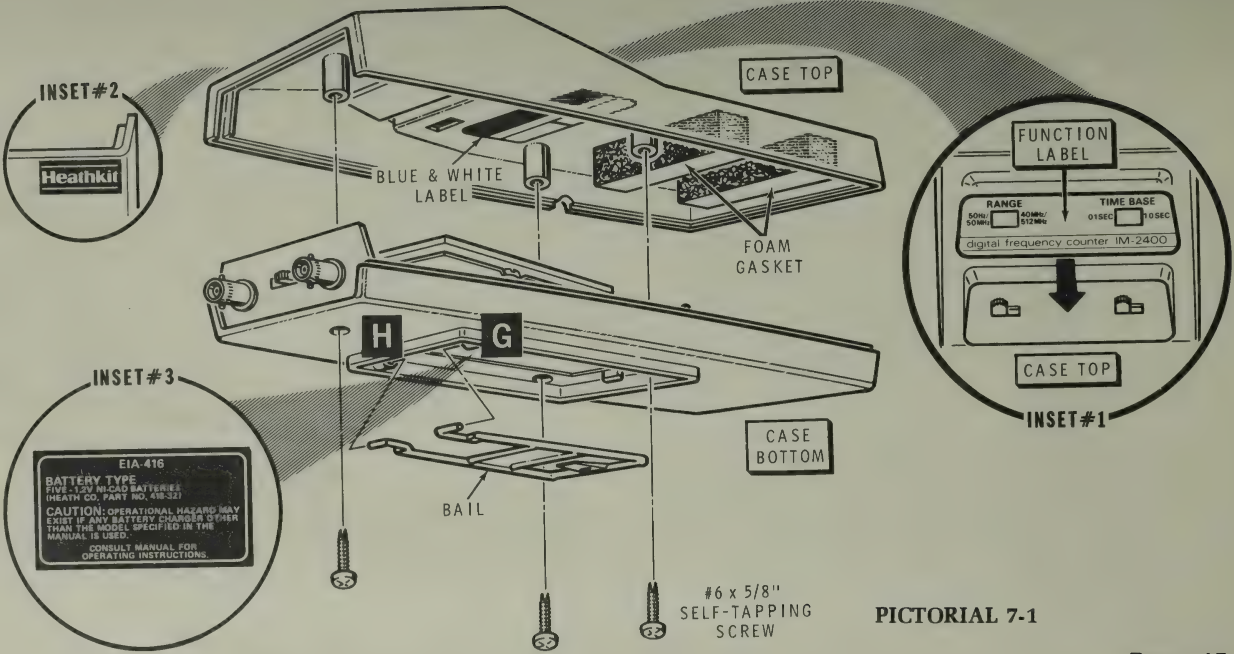
PICTORIAL 5-3


INSET #1
BEND UP 90°
3/8" SOLDER LUG
LOCKWASHER
3/8" SOLDER LUG
INPUT PANEL
SPDT SWITCH
END PANEL
J1
J3
SW1
BNC JACK

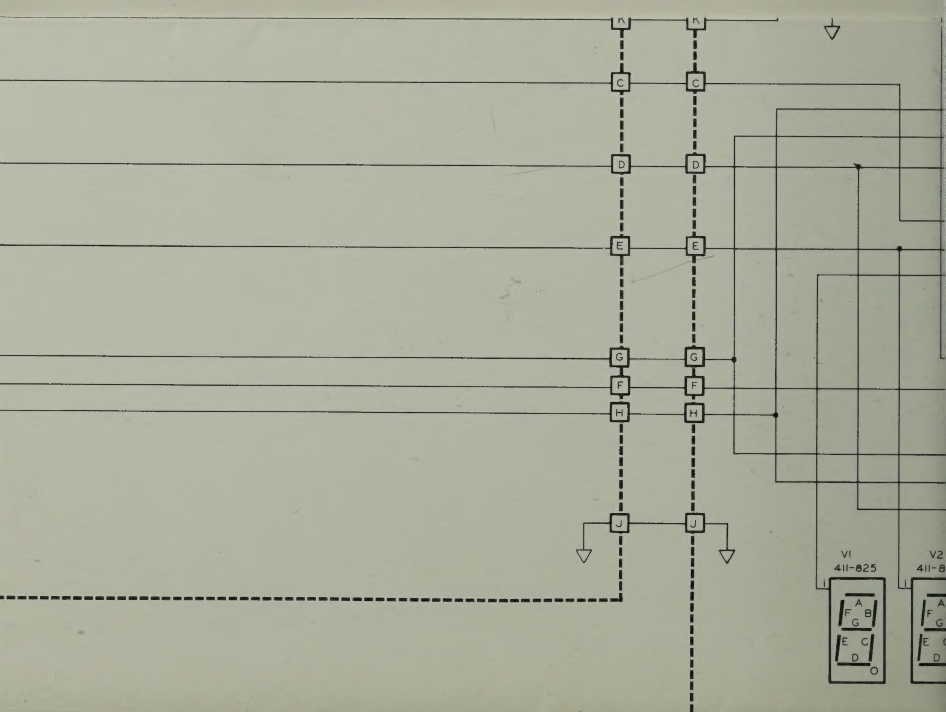
Detail 5-3A

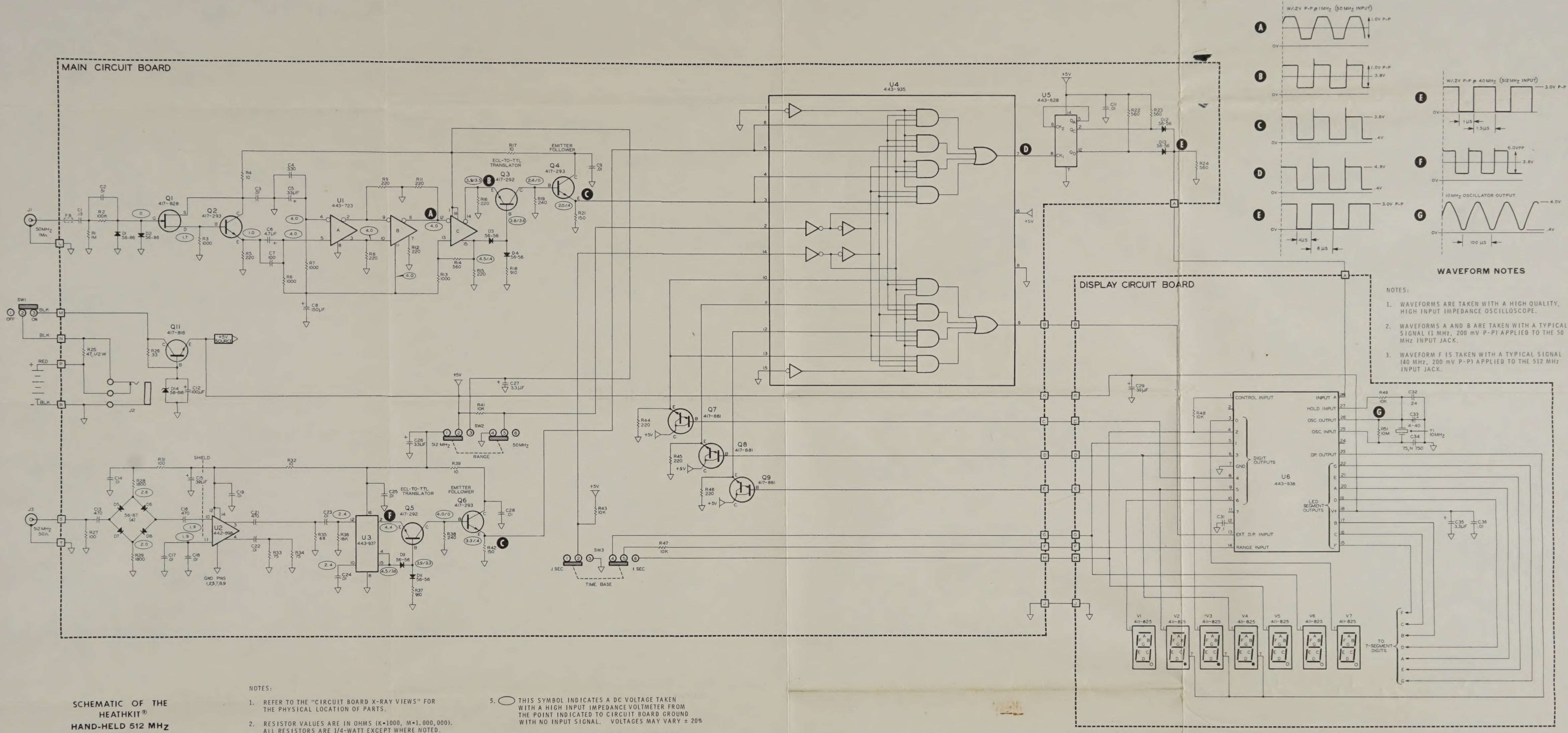


PICTORIAL 6-3


INSET#2
Heathkit
CASE TOP
BLUE & WHITE LABEL
FOAM GASKET
FUNCTION LABEL
RANGE
50Hz/ 50MHz
40MHz/ 512MHz
TIME BASE
01SEC
10SEC
digital frequency counter IM-2400
CASE TOP
INSET#1
H
G
INSET#3
EIA-416
BATTERY TYPE
FIVE-1.2V NI-CAD BATTERIES
(HEATH CO. PART NO. 418-32)
CAUTION: OPERATIONAL HAZARD MAY EXIST IF ANY BATTERY CHARGER OTHER THAN THE MODEL SPECIFIED IN THE MANUAL IS USED.
CONSULT MANUAL FOR OPERATING INSTRUCTIONS.
CASE BOTTOM
BAIL
#6 x 5/8" SELF-TAPPING SCREW

PICTORIAL 7-1


K
K
C
C
D
D
E
E
G
G
F
F
H
H
J
J
V1
411-825
1
A
F
B
G
E
C
D
V2
411-8
1
A
F
G
E
D



WAVEFORM NOTES

NOTES:

1. WAVEFORMS ARE TAKEN WITH A HIGH QUALITY, HIGH INPUT IMPEDANCE OSCILLOSCOPE.
2. WAVEFORMS A AND B ARE TAKEN WITH A TYPICAL SIGNAL (1 MHz, 200 mV P-P) APPLIED TO THE 50 MHz INPUT JACK.
3. WAVEFORM F IS TAKEN WITH A TYPICAL SIGNAL (40 MHz, 200 mV P-P) APPLIED TO THE 512 MHz INPUT JACK.

SCHEMATIC OF THE
HEATHKIT®
HAND-HELD 512 MHz
FREQUENCY COUNTER
MODEL IM/SM-2400

NOTES:

1. REFER TO THE "CIRCUIT BOARD X-RAY VIEWS" FOR THE PHYSICAL LOCATION OF PARTS.
2. RESISTOR VALUES ARE IN OHMS (K=1000, M=1,000,000). ALL RESISTORS ARE 1/4-WATT EXCEPT WHERE NOTED.
3. CAPACITOR VALUES LARGER THAN 1.0 ARE IN pF AND CAPACITOR VALUES LESS THAN 1.0 ARE IN µF UNLESS OTHERWISE NOTED.
4. ▽ THIS SYMBOL INDICATES CIRCUIT BOARD GROUND.
5. ○ THIS SYMBOL INDICATES A DC VOLTAGE TAKEN WITH A HIGH INPUT IMPEDANCE VOLTMETER FROM THE POINT INDICATED TO CIRCUIT BOARD GROUND WITH NO INPUT SIGNAL. VOLTAGES MAY VARY ± 20%
6. VOLTAGES MEASURED ON TRANSISTORS Q3 THROUGH Q6 MAY BE EITHER OF THE TWO VALUES SHOWN. THESE TRANSISTORS ARE USED AS TWO-STATE DEVICES AND CAN CHANGE STATE WHEN THE VOLTMETER PROBE IS CONNECTED TO THE COUNTER CIRCUITRY.

Part of 595-2382

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